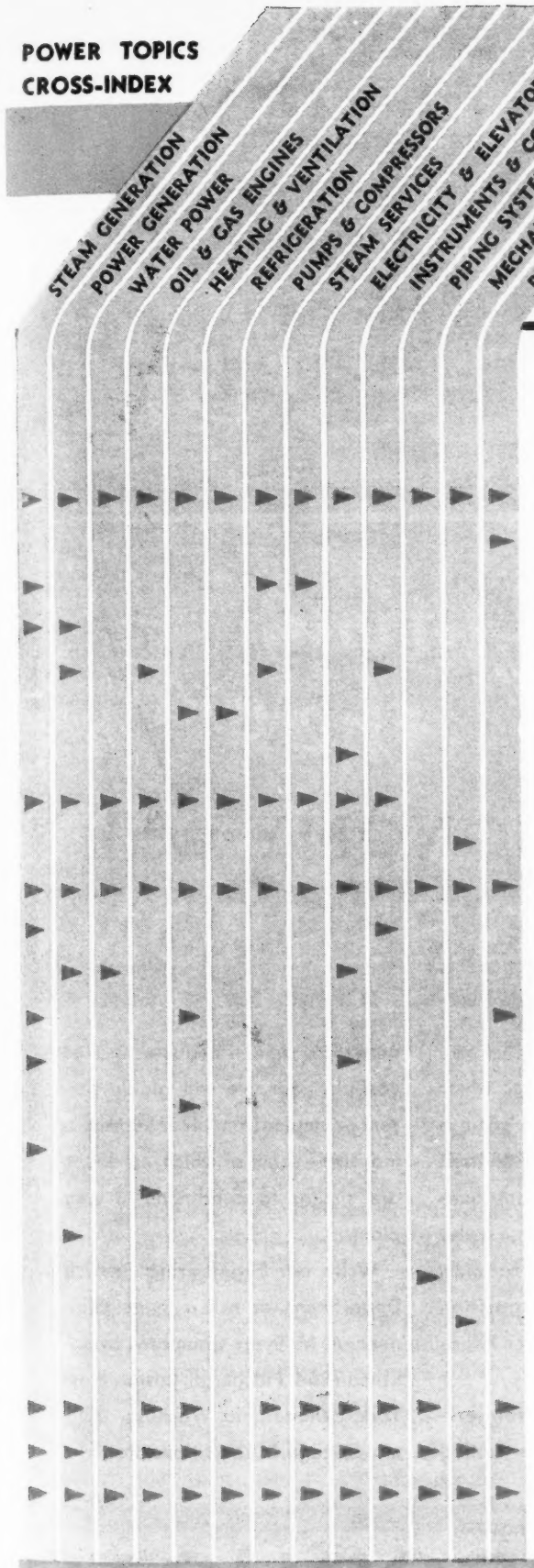

Volume 79 Number 4

POWER

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April, 1935

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McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

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GREENVILLE, S. C., 1301 Woodside Bldg.
LONDON, Aldwych House, Aldwych, London, W.C.2

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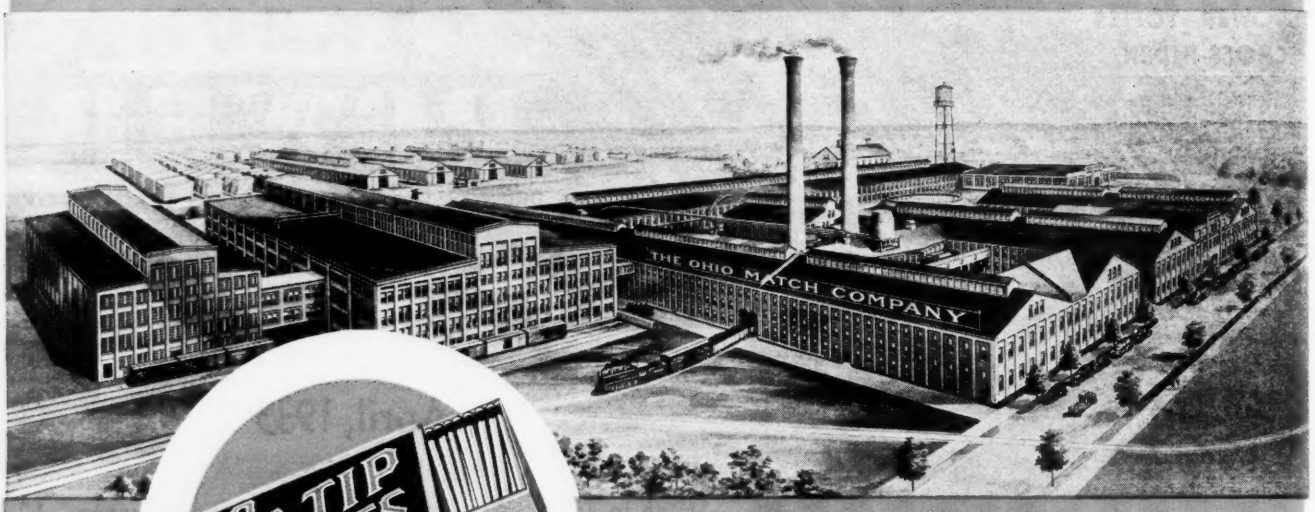

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POWER

Established 1884
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PHILIP W. SWAIN, *Editor*

Introducing ten comprehensive articles that will help power men to sensible practices in maintaining equipment in first-class working order

STITCH IN TIME

OLD as mankind, practiced by the few, remembered always too late by the unwary, is the fact that a stitch in time saves nine. It's one of the few success formulas that really works.

• BACK IN 1928 this creed had moved far in America. In that year millions visited the dentist every six months "whether they needed it or not." Result: teeth lasted longer, looked better, generated more food-grinding foot pounds; digestions improved. And in the end they paid no more to the dentist—often less.

• THE SAME MILLIONS had their cars inspected at regular intervals—greased, tuned up and adjusted brakes by schedule—and saved in hospital bills, fenders and gasoline, also in garage bills.

• SOME HUNDREDS OF THOUSANDS of Americans plunked down $10 to $50 annually for routine medical examination whether they felt well or not, because it would cost like the devil to be really sick. And, besides, who wanted to die before his time?

• IT WAS THE SAME then in industry. Many factories, buildings, institutions, practiced the ounce of prevention to avoid the pound of cure. More didn't, of course.

• THEN CAME 1929 and the aftermath—five years of universal neglect. Too bad! We see it now as the piled-up trouble begins to liquidate in hospitals, dentist's chairs and equipment junkyards. Five years of starvation maintenance haven't been good for anybody or anything, not even for skinny wallets. For the piper always gets his pay in the end—and with interest.

• YET ONE WORTH-WHILE THING has been created along with this pile of human and material junk: A psychological moment, a moment when owners, plant engineers and workers, face to face with this devastation, can agree that it won't happen again. But better get it down in writing, for memories are short and the owner recently "too poor" for preventive maintenance may soon be "too busy" to be bothered.

• RIGHT NOW is the time when maintenance can be pulled out of chaos by establishing a fixed policy of prevention and setting up a hard-boiled system of fixing things, *before* they break. Another such chance may not come for years.

• TO THE SOLUTION OF this intensely practical problem the editors of *Power* contribute the next twenty pages of maintenance tips and methods.

First...

A POLICY AND A PLAN

IN THE pages that follow you will find hundreds of maintenance ideas, specific to various types of equipment, tested in the fires of experience. These are essential because the practice of maintenance, like the practice of medicine or surgery, is a near-infinity of detail.

But it's always a mistake to plunge into detail before you know where you're going. Detail should be preceded by analysis, then a policy and then a plan.

In the past, and particularly during depression years, only the exceptional plant has practiced *preventive* maintenance, fixing things before they break instead of afterwards.

Right now, when the damage and the need of less slipshod methods is most evident, is the time to analyze maintenance, fix a policy and establish a plan of operation.

The policy might be put thus: "It is the policy of this company to spend money to save money—specifically, to maintain equipment through an orderly routine before trouble occurs, rather than through hysterical patching of the results of neglect. To this end we propose to set up an ample yearly budget for preventive maintenance." Get that settled, if possible, right now. Then start! How?

First, we suggest, by the biggest general housecleaning in years. Housecleaning should come first for psychological reasons. It is a ceremony as well as a job; to both men and management it marks a clean break with the old hit-and-miss ways. At the same time, and in a single operation, this housecleaning compels looking and creates visibility. There'll be plenty to see, and what is seen will feed facts to the analysis, inspire thought and contribute to a workable plan.

After this housecleaning ceremony is over, and the casualty reports are in, is a good time to settle down at the desk for two or three days of intensive planning.

From now on maintenance is to be managed—managed for prevention. This abolishes the traditional automatic tickler system of burned-out motors and boiler tubes, hot bearings, short circuits, screeching gears. Charts and schedules must take their place.

Many systems of planned maintenance are possible and each has its advantages. Details are less important than the main points to be covered, which are these:

1. Set up a complete schedule of maintenance, covering all items.

2. Include cleaning, inspection and lubrication.

3. By written check forms, with tickler and follow-up, make certain that the men concerned know when these jobs are due and that they finish them on time.

4. Leave no doubt as to *who* is responsible for each job.

Individual systems of doing this are legion. Each has its good points. Here is a sample, applicable to many plants.

In this particular plant the plant engineer has established a master maintenance schedule and a card system for follow-up and records—a card for each machine. The cards are individually "flagged" to come out at regular periods (weekly, monthly, the first of January or June, etc.)

An Example

A card comes out, say, for a piece of electrical equipment. The plant engineer's clerk sends a check slip to the electrician and places the card in a deferred file where it stays as a reminder until the slip comes back with instruction items checked. These items cover cleaning, lubrication, inspection, minor adjustments and repairs.

The electrician is expected to note on the slip any possible sources of trouble calling for further attention. When the slip comes back the plant engineer authorizes the special work and (if required) purchase of materials. The clerk checks the inspection, etc., on the file card, also noting on the back the nature and cost of special work. This gives a case history for each machine and spots trouble-making machines, men and methods.

In a large organization, the slips pass up and down the line through the hands of foremen or supervisors (e.g. chief millwright or foreman electrician). This, very briefly, is one system. There are many variations.

One well-known plant engineer believes firmly in making a given group of equipment (the heating system, for example) the responsibility of one man. He even goes so far as to set up a maintenance budget for that group, with a bonus to the man of half of any saving he can make. This encourages thrift in the use of materials and preventive work to forestall expensive repairs. But it's only fair to say that many engineers consider a maintenance bonus impracticable.

Avoid extremes in the system: on the one hand, red tape that swamps the clerical force and damps initiative; on the other, loose hit-or-miss maintenance that leads to neglect and damaged equipment. The golden mean here as everywhere.

BOILER-ROOM EQUIPMENT

Photo courtesy A. M. Byers Co.

Installing 443 3-in. O.D., 12-gage, wrought-iron tubes in an air preheater at Crawford Ave. Station, Chicago, to overcome a corrosion problem due to gases cooled below dewpoint

MAINTENANCE in the boiler room is more affected by operating methods than is that in any other part of the power house. For example, lack of or improper feedwater treatment may cause rapid scale formation in the boiler and make necessary more frequent turbining. It may even cause boiler-metal embrittlement or tube burnouts. Combustion equipment maintenance will be too high if the wrong kind of coal is used, and continuous high ratings are likely to decrease the life of furnace refractories. Too little excess air and overfire pressure will also raise hob with the furnace. Thus any drive for decreased maintenance must have operation as its starting point.

Decreasing maintenance cost by deferred maintenance is the poorest kind of economy, as it not only results in increased consumption of the fuel pile but also makes eventual repair more costly. Good management guards against the evil of deferred maintenance.

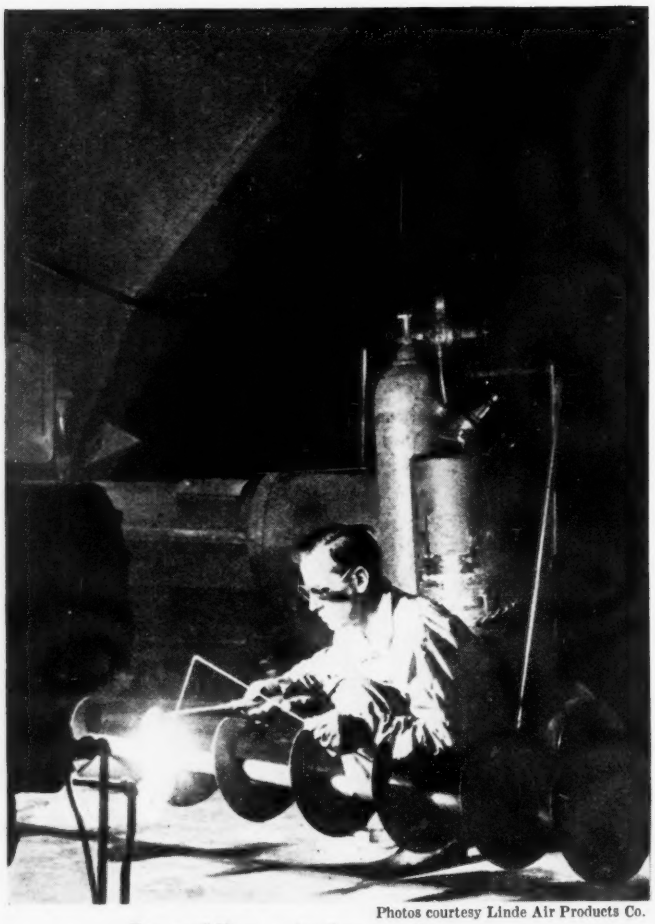
Records to be helpful in finding the cause of excessive maintenance should not only give over-all costs but also show the work done on each major element in the boiler room. This kind of record makes it easy to find those units or parts which must be repaired too frequently and so should be changed in design or material to prevent further trouble. Maintenance records of this kind are not hard to keep. It simply means starting a book or card for each boiler, furnace, stoker, etc., and entering in it the date and brief description of each repair job.

Effective maintenance to a large extent depends upon cooperation of the operating personnel in reporting defective equipment. Usually such reports on a boiler are kept until enough have accumulated to warrant taking the unit out of service. Just how much work should be allowed to accumulate is largely a matter of judgment and depends upon how serious the breakdown and upon operating conditions in a given plant. But even though no maintenance work may be scheduled, take boilers out of service at least once every three months to inspect the external parts. Frequency of inspecting internal surface depends largely upon the character of the feedwater. It costs money to empty a boiler, so don't do this job more frequently than necessary. When the feedwater is practically all condensate, it may be necessary to inspect the water surface but once a year, whereas with poor water inspections must be more frequent.

Inspect the water side of a boiler first to see if any corrosion has taken place, second to see how much scale has accumulated. If much scale is present, tubes should of course be turbined. If corrosion or pitting is found, look for air leaks into the feedwater and employ a chemist to determine the cause. But don't stop an inspection there. Certain types of feedwater cause the boiler metal to become embrittled and to crack. Such cracks are usually fine—look for them around rivets, tube holes and wherever the metal may be subject to high stresses. Look at tube ends to see that none have slipped or corroded thin. Inspect the feedwater trough and steam baffles for tightness.

If the blow-down valves have been leaking, fix them while the boiler is empty. Some types of valves must be reground to stop leaking; others require only new packing.

External inspection involves more than just the boiler. While looking for leaks where the tubes are rolled into the drum or headers, watch the amount of soot on them. Check condition of the soot blowers and look for leaks in baffles due to broken tile. It seems unnecessary to stress the economy of fixing defects in any of these places. Soot blowers that won't turn or that have nozzles burnt out or adjusted for the wrong arc of travel mean inadequate removal of soot and higher flue-gas temperature. The same operating loss is caused by leaky baffles which allow flue gas to short-circuit boiler surface. Tube-supporting baffles should be of proper shape to serve the pur-



Photos courtesy Linde Air Products Co.

Gas-welding a broken coal-conveyor screw

pose. It may be more economical to replace a sound but crooked tube than to continue the loss from gas leaking past a poorly fitting baffle.

A distorted tube is often a cause of needless worry. That a tube once straight has changed its shape due to exposure to high temperature does not mean it is unsafe. But inspect a badly warped tube closely to see if it has slipped in the tube sheet and needs re-expanding. If it is cracked near the sheet replace it. Also replace tubes with bags or chestnuts.

Occasionally an engineer is confronted with the necessity of replacing a tube and finds none of the proper shape in stock. Once confronted with this situation, the engineer will see to it that there is always in stock at least one tube of each shape required. If the boiler is needed for production, the hole in the tube sheets or headers may be closed with hole plates or quill tubes as an emergency measure.

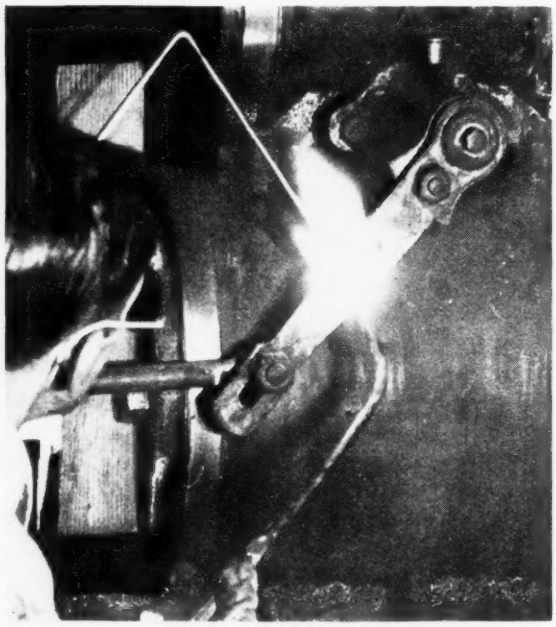
In the furnace, a stitch in time may save a lot of work later on. If your furnace is of the refractory type, repair spalled brickwork . If only a few bricks have gone, a repair with refractory cement may prevent other neighboring bricks from failing. If the furnace has been badly slagged it is usually a sign that over-fire pressure has existed for considerable periods or that not enough excess air has been used. This suggests a check up of the over-fire draft gage, particularly its connection to the boiler setting where it may have become clogged. Likewise check the CO_2 or boiler meter to see if its readings are low.

If the boiler is fired by underfeed stoker watch for burnt tuyeres,. Replace any tuyere that has burnt so that the air ports are clogged, or chip the port free of burnt metal. Failure to do so only courts trouble, as the tuyere will run hot, cause clinkers and probably cause tuyeres below it to burn also. It is also good practice to clean the air ports of all the tuyeres, a welding rod being a handy tool for this job.

Check all ram box caps, side plates, dump grates or clinker grinders and if burnt or cracked replace them. If clinker grinders are used, tighten bearing holding-down bolts and inspect the ratchet pawl mechanism. Modern clinker grinder shells are arranged with replaceable teeth. When shells have to be replaced, use the new type, as maintenance costs are thereby decreased.

About every four to six months, check the stroke of secondary rams or pushers, particularly in old stoker. This can be done in the furnace by running the stoker and marking the travel with chalk. Improper travel can usually be changed with filler washers.

Tests on certain types of underfeed stokers have shown that a considerable part of the air supply does not go through the tuyeres, but leaks through



Bronze-welding a broken pump part in place

other parts of the stoker, such as ram boxes. This robs the tuyeres of part of the air supply that cools them. Consequently, when this leakage is large, tuyeres tend to run hot and maintenance due to burnouts may be high. It is good practice to cement all ram-box joints and other cracks to minimize air leakage. High-temperature cements Tharco and Pecora are reported satisfactory for the purpose.

If the boiler is fired by chain- or traveling-grate stoker, look for and replace burnt side plates. Inspect the gate and replace worn or cracked tile or cast-

iron sections. With this type of stoker, the grates may be inspected at any time during operation. In some cases burnt keys or grate parts may be replaced while the stoker is running. Skids need not be inspected more often than every six months.

Stoker parts outside of the furnace also require occasional maintenance. Gear boxes should be overhauled once a year. If one element of the gears has to be replaced, replace the mating gear also, especially if in the high-speed part of the box. If the stoker is old and gear-box repair is indicated, it may pay to replace the entire box. Modern gear boxes have bushed bearings and use gears instead of worm and wheels.

In some boxes, trouble is experienced with oil in the upper part of the box leaking into the lower gear box. A simple, easily installed oil-return device has been developed to overcome this trouble.

As the ram and ram boxes wear, coal sifting increases and makes for a dirty boiler room. If the wear is allowed to go too far the ram may bind in the box and stop the stoker. In modern stokers removable sleeves are provided that can be easily replaced. In some makes the sleeve is split so that wear can be taken up until the metal in the sleeve has worn down to $\frac{1}{16}$ in. If wear in an old type ram box has progressed so far it causes binding, it is usually cheaper to replace.

If crankshaft bearings wear too rapidly, check for alignment. Stoker supporting steel may have settled unevenly or have sprung from overheating. It is good practice to make it routine to grease every shift.

No Local Replacements

There is often a considerable temptation to order cast-iron replacements from a local foundry because cheaper prices per pound are quoted. This invariably is poor economy for several reasons, a few of which are: The local foundry makes a metal easy to machine, whereas the manufacturer's metal is made to withstand heat. Local foundry castings are generally not as uniform and not as close to dimensions as those furnished by the manufacturer.

Most important is that the manufacturer keeps a record of the replacement parts you order. If your orders are excessive he will send a representative to find out why you are burning so much metal. There are many instances where this has resulted in maintenance costs cut in half and efficiency improved, often by simple changes in operation. If replacement parts are ordered from the local foundry, the manufacturer has no record with which to give this service.

A chart such as that shown on page 176, on which the location of stoker replacement or maintenance can be marked, will be found of value in decreasing maintenance cost. Such a record may show, for example, that a certain group of tuyerers have to be replaced repeateedly. This may be due to unequal distribution of air in the stoker windbox and when remedied will stop a maintenance item that otherwise would have continued. Similar records may be made up and kept to good advantage for furnace refractory repairs.

Under good operating conditions, stoker maintenance costs may run from 2 to 5 cents per ton of coal. Often they are much higher than this, but maintenance costs of 10 and 15 cents per ton are unsatisfactory. If yours run that high, find the reason. With chain or traveling grates, maintenance costs of $1\frac{1}{2}$ to 3 cents a ton are reasonable, and 7 to 10 cents per ton should be considered high. These figures are for material and labor.

Maintenance of pulverized-coal, oil- or gas-firing equipment differs greatly from that on stokers in that practically all repair work is outside the furnace. Likewise, operating methods have little influence on the amount of work necessary.

Pulverized Coal Units

In the case of pulverized coal, most of the maintenance work is on the mills, feeders and exhauster fans. Mill maintenance is greatly influenced by the abrasive character of the coal. Based on eastern bituminous coal in both unit and storage systems, maintenance costs are 4 to 7 cents per ton of coal milled. With lignite, this may drop to 2 to 4 cents per ton.

Necessary and periodic replacements in unit-type pulverizers, in order of replacement frequency, are: pulverizer liners, ribs, hammers and fan blades. Other parts are long lived and seldom need replacement.

Great care should be taken in mounting rotating parts to keep the rotor in balance. Hammers should be weighed to $\frac{1}{2}$ oz. Opposite hammers on the same disk should be of equal weights within these limits. This procedure is also necessary with the installation of new fan blades. Grind off the trailing side of hammers or fan blades slightly to lighten them when their weight exceeds that of the opposite part.

Hammers in the last two stages should always be in the best condition. Shift these when they are moderately worn (after from 1,200 to 1,500 hr. of service with average coal) to the first stages and install new hammers on the last stages. As hammers in the first stage last about 3,000 hr., they are ready to be scrapped.

When workmen are making internal repairs in a pulverizer, the starting switch or valve should always be tagged or locked off, and as an additional precaution against injury two steel bars long enough to protrude several inches beyond each end of the housing should be laid from end to end under the hammer disks, one bar on each side of the rotor. This makes it impossible for the rotor to revolve in either direction. Serious accidents have occurred when a man climbed on the rotor which turned as he stepped on it.

Preventive maintenance consists principally of opening the pulverizer for weekly inspection and replacing any parts necessary. Lubrication of bearings also comes under this heading and calls for strict observance of the manufacturer's recommendations. Due to the speed, heat, load and dusty location, these bearings must receive very careful attention in

order to have trouble-free operating performance.

There is a great variety of coal and ash-handling equipment in use in power plants, consequently maintenance of only a few of the more frequently used types can be touched upon. In general, it can be said that maintenance work will be decreased if good housekeeping is practiced. After each run, all coal siftings should be cleaned up to prevent the constant accumulation from wedging under the conveyor. Attention to lubrication of bearings, and rollers designed to keep out dust are imperative for long life. The vast differences in types of coal-handling systems make it difficult to give any average figure for maintenance cost, but in properly maintained plants it may run between 2.5 and 6 cents per ton of coal handled.

Pivoted bucket carriers and belts are used to a great extent in coal handling. In some plants, bucket carriers are rebuilt every 7 to 9 years. At this overhaul, chain links, bucket trunnions and lips, and bucket axles may have to be renewed. Sometimes it is possible to ream out the links and rollers to $\frac{1}{4}$ in. larger diameter and put in a new axle, thus saving roller and chain links. Lips may be built up by welding. Check the rails for alignment. At the corners they may have to be replaced.

Barring accident, belts should last 3 to 6 years. They should not be run tighter than is necessary to prevent slipping, as an over-tight belt wears out rapidly. Keep them properly aligned by adjusting the idlers. About once a week go over the belt carefully for cuts in the protective rubber coating. Breaks of any character permit moisture to get into the fabric, rot it, and so weaken it. Clean these spots thoroughly, first with gasoline, then with alcohol to remove moisture, and fill with rubber cement or non-drying paint.

Economizers may be inspected when the boiler is inspected. They require pretty much the same kind of maintenance. Corrosion both inside and out is likely to be a more serious problem because it is the first surface to be attacked by oxygen present in the feedwater. Low gas temperature may cause moisture condensation, which in the presence of soot and sulphur from the coal, causes active corrosion on the gas-side surface. Many economizers are 2-pass, with a soot-collecting hopper at the turn. Watch the hopper closely for corrosion. Lining them with cement applied with a cement gun has helped resist soot.

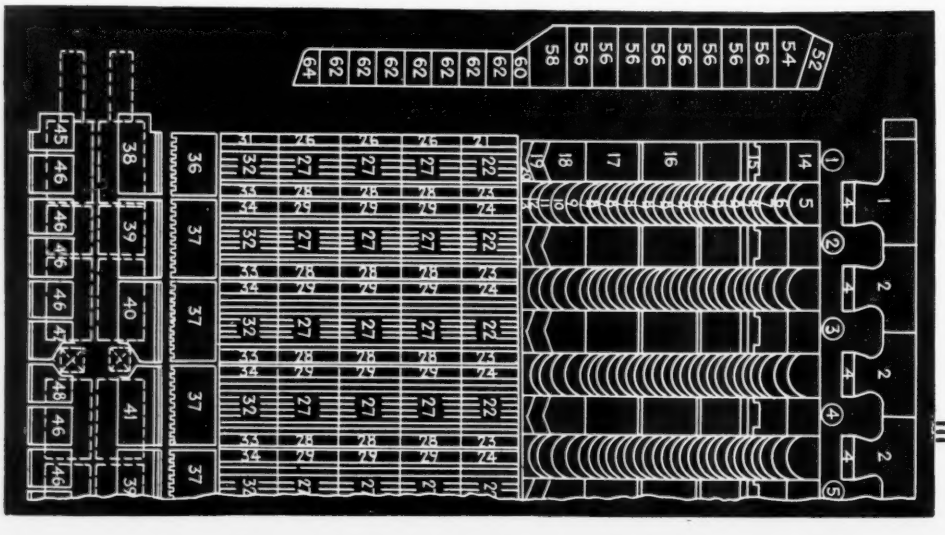
Again in air preheaters, the maintenance problem is that of fighting corrosion. Little success has been had with paints for this purpose, and from a maintenance point of view about all that can be done is to replace the part when corroded through. Some precautions can be taken to decrease the severity of this problem. Even distribution of gas flow is important, as soot will accumulate and temperatures will be low in dead pockets and corrosion excessive. Keep the temperature of the exit gas well above the dew-point by heating the inlet air. Keep the gas surface clean to insure the highest metal temperature, and so decrease condensation on it. In regenerative air preheaters, inspect and clean bearing and motor drive.

Draft Fans

Forced-draft fans require little attention other than the usual cleaning of bearings on both motor and fan. But induced-draft fans and exhauster fans on pulverized-coal systems occasionally are subject to considerable blade wear due to erosion. In the case of pulverized-coal fans, this wear has been decreased to a large extent by placing the fan in the return-air line after the separator so that the air handled carries a relatively small amount of coal. Stellite has met with some success in building up worn blades, but when using this method care should be exercised not to destroy fan balance. The flexible coupling between drive and induced-draft fan must be watched carefully, as differences in temperatures of fan and motor bearing pedestals may cause misalignment.

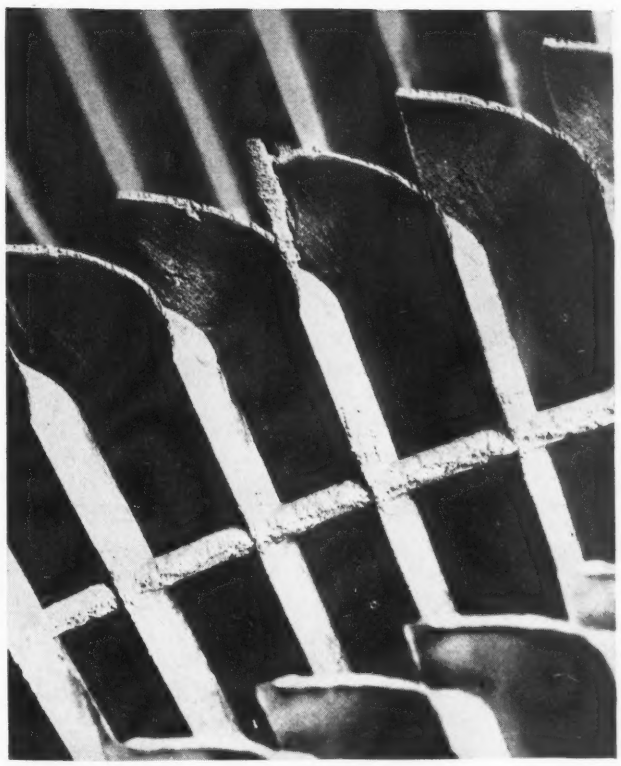
There are many pumps of different types used for a variety of services about the power plant. Every effort should be made to overhaul all of them once a year. In most cases this does not involve much more than inspection, cleaning bearings and renewing oil. Occasionally, in the case of centrifugal pumps, inspection discloses corrosion or wear in the impeller, diffusion vanes and shaft sleeves. Sometimes, and particularly if found in time, the worn part can be put in perfect condition by laying new metal in the eroded spot with welding torch or metal-spray gun. In boiler feed, hot drip and condensate pumps, impeller erosion is often caused by insufficient suction head.

Watch shaft seals on condenser hot-well pumps, as this is a prevalent source of air leakage into feedwater. Proper packing correctly installed should give far more than a year's service. Don't use cotton, hemp, or flax packing under high temperatures, and screw up gland nuts only finger tight. Inspect valves, plungers, pistons, rod packing and steam-valve operating linkages in steam-driven reciprocating pumps.



Portion of a stoker maintenance check chart that permits recording replacements

TURBINES and ENGINES



Turbine blades are often found in this condition when the unit is opened for inspection

MAINTENANCE work may be divided into two parts—that which must be done throughout the year as conditions arise and that found necessary when a unit is taken down for general overhaul. Turbine overhauling should be done every 1 to 2 years, assuming that the unit has given satisfactory service within this period. Sometimes vibration or accumulations of scale on the turbine blading makes more frequent overhauling advisable.

Overhauling is often only a matter of cleaning and checking alignment, blade, nozzle and bearing conditions. Though no trouble may be found it is highly important and profitable to inspect at regular intervals. Only in this way can you find the small defects which, if allowed to grow, may cause shutdown at a bad time or even wreck the machine.

When the turbine is opened, inspect buckets and nozzles first. You can see their condition with respect to scale accumulation and erosion or corrosion easily, but the progress of erosion as compared with the previous inspection is more difficult because there is usually no direct means of comparison, and you'll have to rely on your memory. Photography will help you greatly in determining the extent of progressive erosion and in comparing turbine condiiton with previous inspections. Just keep a picture record of each overhaul.

Searching for Cracks

A more painstaking job is the search for small cracks in the blading, usually requiring the use of a magnifying glass. Recently a method has been devised for easily finding even the very small sub-surface cracks. This involves producing a magnetic field in the blading and sifting a magnetic powder called "Magnaflux" on to the blades. Tapping the blade causes the powder to concentrate at points of greatest flux density and outline any cracks that may be present. This method, however, can be applied only to blades that can be magnetized.

If you find erosion to be excessive, take steps to decrease the moisture present, or if this cannot be done Stellite shields welded on the leading edge of the affected blades will decrease the trouble materially. You can repair a certain amount of pitting or erosion by filling in with silver solder.

Before the rotor is removed for blade examination, check alignment and clearances. Check alignment at the coupling between the turbine and generator shafts. If the shafts are not parallel, the space between the two halves of the coupling will change as the two shafts are rotated together. Determine eccentricity by placing a straight-edge across the edges of the two coupling halves and observing any change in clearance as the shafts are rotated. If these checks do not show misalignment, and there is no coupling wear, it is not necessary in small machines to check each bearing. Make these checks again when the unit is reassembled.

In the case of reaction turbines, check radial clearance and center the shaft by adjusting the bearings. After such adjustments are made, check alignment of the shafts again, and change generator-shaft position if necessary. Keep a record of the changes made and compare with previous records, to determine rate of bearing wear and possible foundation settlement.

In impulse turbines check the axial clearance. This is best done when the unit is hot and operating at about 10 per cent of normal speed. Do it by shifting the axial position of the shaft carefully by moving the thrust bearing until you hear a rub. In this way you can find maximum shaft travel in both directions and give the proper clearance as directed by the manufacturer. Also check shaft-seal clearance and condition, although excessive sealing steam consumption or leakage will have given you warning of trouble here.

It is most important to go over the entire oiling system. Take down all oil piping and clean it thoroughly. Also clean bearing oil passages, oil storage tank and oil cooler. Inspect the oil pump drive for wear and also the auxiliary oil pump. If you haven't inspected with safety against

oil fires in mind, now is a good time to do it and make whatever changes are necessary. Good rules governing turbine oil piping have been made by the Prime Movers Committee of Edison Institute, and the manufacturers will be glad to assist in this important work.

Main turbine-governor and bleeder control mechanisms also require overhauling and inspection. Wherever excessive play in linkage joints is found, replace either bushings, pins or both with new parts. Clean and polish if necessary all knife edges and *V* blocks. Check relay and power pistons for free-movement and replace packing.

Among the maintenance work that usually has to be done between overhauls are valve grinding, oil cooler cleaning and inspection for leaks, valve stem packing and emergency trip mechanism checking. Of course if any serious vibration occurs, it must be remedied at the earliest opportunity. New instruments and methods of balancing have been developed that take balancing in the field out of the realm of guesswork, and make possible a more accurate and quicker job.

Steam Engines

Steam engines need overhauling about as frequently as turbines, although, unlike turbines, they can be kept in operation without great danger, even though in run-down condition. One time-tried engine maintenance schedule requires that the governor over-speed trip be checked weekly and inspected for wear every 3 months; valves checked for leakage, valve gear readjusted, crosshead shoe and rod bearings checked every 6 months; cylinder bore and main bearings checked every year; and piston pulled, rod packing withdrawn and shaft checked for alignment every 2 years.

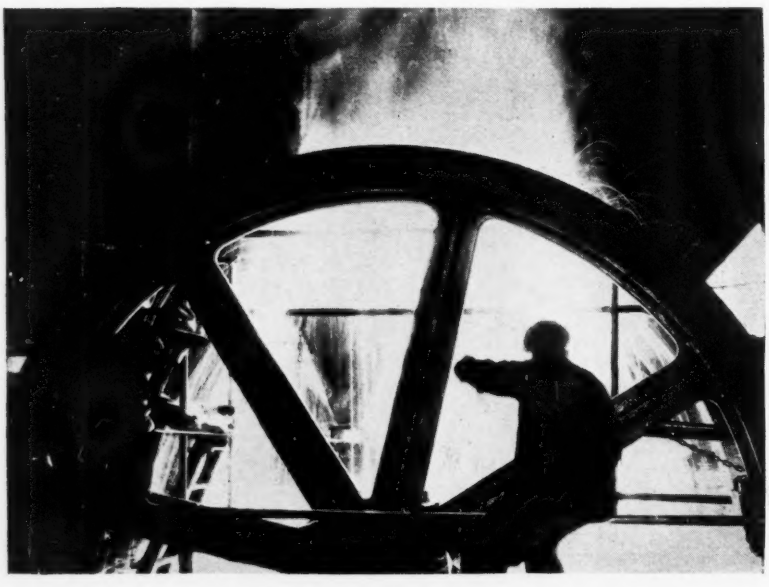
Valve wear and leakage must be expected in all engines after some period of operation. Increased steam consumption and inability to carry the load with the usual cutoff are warning signs of valve leakage, but may also be caused by leakage past the piston or valves out of adjustment. When steam consumption mounts it is better to indicate the engine and diagnose the trouble from the diagram than to try to find it by hit or miss methods. Value of the engine indicator in finding and correcting-trouble can't be over-estimated.

Don't let steam leak past the piston rod at the stuffing box for longer than can possibly be helped. It will eventually score the rod and will then always give trouble. If adjustment does not stop the leak, new packing may have to be put in. Remember that newly adjusted metallic pack will probably leak until it has worn in. Excessive wear of stuffing-box packing may be due either to lack of lubrication or a low piston rod due to crosshead-shoe wear. On small engines crosshead wear can be tested during weekly inspection by jumping the crosshead with a small bar. On large engines use feelers or calipers to check crosshead-shoe adjustment. When an engine has a tail rod it is also necessary to make sure the piston is central in the cylinder. Engine manufacturers usually give instructions for this or provide special trams. Compensate for guide wear as soon as detected if you want to avoid stuffing-box trouble.

Slight cylinder wear, provided it is uniform, is not serious. It may cause the piston rings to wear more rapidly at their sides and to wear the ring-groove sides. But a scored cylinder is a serious defect and when extensive can be remedied only by reboring. Scoring usually occurs when poor lubrication has permitted the cylinder to become dry. The rings then cut into the cylinder and may remove enough metal to cause severe leakage. Force-feed lubrication to the cylinder will usually eliminate this trouble.

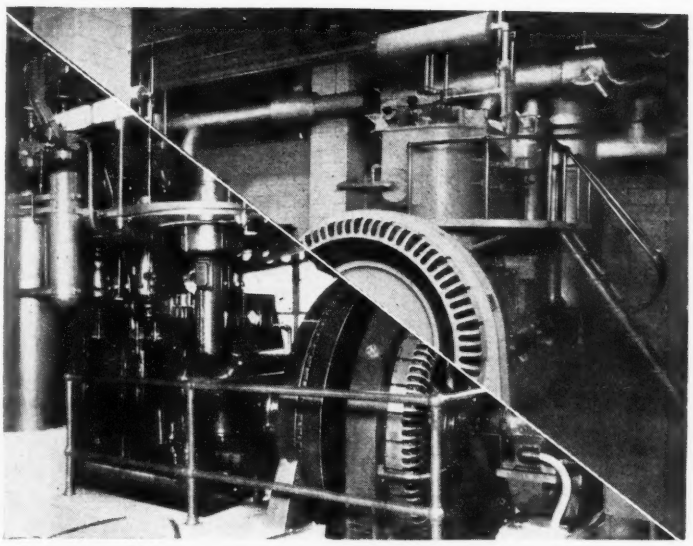
Main bearings should not require much maintenance, but connecting-rod bearings usually require taking up at each overhaul, particularly at the crankpin end. If bearings run hot, look for misalignment, or possibly the shaft may be sprung. If the shaft is sprung, both main bearings and crank bearing will probably run hot, while if some misalignment has occurred usually only one bearing will be hot. In the latter case the trouble is easily remedied by alignment, but in the other case a new shaft must usually be installed.

Smooth engine operation depends also on smooth governor action. To insure this, overhaul the governor once a year. Clean all moving parts and check for wear. In certain types of flywheel governors, the main pin is provided with hardened steel sleeves and roller bearings. When the engine carries about the same load from day to day, these rollers constantly move back and forth over a small arc. This tends to wear hollows and when this happens engine governing becomes jumpy. Replacing or regrinding the sleeves may sometimes be put off by shifting the position of the sleeve so that the rollers bear on a different portion of the sleeve surface. In one plant these sleeves have to be replaced about every two years. When governor parts are replaced it is best to obtain them from the factory as they are usually made of special hardened steel designed to resist wear. Serious accidents have occurred when homemade pins of soft steel wore through unexpectedly.



In many emergencies welding is a god-send. Here a broken engine shaft is being Thermit-welded to prevent a serious transportation delay

OIL and GAS ENGINES



Large or small, gas or oil engine, maintenance is a vital element in operation

WHAT is this diesel maintenance bugaboo, anyway? Or is there one? Fact is, there isn't one anymore—providing an operator knows his engine as well as a good chauffeur knows his car. Time was when a diesel stopped about as often as it ran, and had to be nursed along like a prima donna, but with better materials, better machining, closer inspection and refined design, those days are gone.

Nowadays, troubles almost always go right back to one of three things—fuel, lubricant, water. If you have clean, good fuel, correct, cool lubricating oil, and clean, soft water, most of your maintenance troubles will never happen. Neglect any one of them and your diesel will simply stop—and that means repair, not maintenance.

Safe-minded men have always had a handful of red lanterns to distribute at points of possible trouble. So does the good diesel operator—in the shape of a pyrometer with thermocouples in each exhaust line, water outlet and oil line, a low-water alarm, a high-temperature alarm in the lubricating oil line plus a safety stop, even automatic electric heaters in the fuel oil line in winter, or when he burns a heavy fuel. He may also add a flowmeter, a lubricating oil pressure gage, an automatic viscosimeter for lubricating oil, a duplicate lubricating oil system driven by motor, an automatic water temperature regulator, and so on. To some people these are just gadgets, but to the intelligent operator they give warning of trouble while there is still time to avoid a shutdown.

Gas engines, too, should be operated with instruments to flag trouble, and with a remote-controlled safety switch to ground the ignition at once in emergency to avoid operation from gas stored in the header. In gas engine operation and maintenance, lubricating oil supply is more important than anything else (the engine uses about 1 gal. per 3,000 rated hp.-hr.) Cooling water is next in importance, the usual engine using water according to the formula $500/(T_2—T_1)$ in gallons per b.hp.-hr., with T_2 outlet temperature (shouldn't be over 140 deg. F.) and T_1 inlet temperature. On slow-speed gas engines, maintenance cost is about 2% of first cost per 8,000-hr. year, on medium-speed units about 3%, and on high-speed about 5. Diesel maintenance cost usually runs from $2 to $5 per hp. per year, high-speed engine figures being higher because first cost per hp. is lower.

In any internal combustion engine, the better the operation the lower the maintenance. The operator who assures himself of proper fuel, cooling water and lubricating oil also runs warm water through his engine jackets constantly, or for a while before he starts up, starts his lubricating oil pumps before he starts the engine (to be sure that an oil film cushions the starting kick) and trains himself to use lowest possible starting-air pressure.

Your maintenance troubles will probably result from: Wrong piston clearances, mechanical defects, fuel system and combustion troubles, cooling water system, lubrication system, or air system failures, starting troubles, or operating troubles. Let's treat each in turn.

WRONG FITS AND CLEARANCES—These usually occur on large bearings on main shaft, cranks and crossheads. Diesel bearings require much more careful fitting than do steam engine bearings, because unit pressures run many times higher (see page 200). Incidentally, a 2-cycle engine won't signal a loose bearing as quickly as a 4-cycle, because the connecting-rod upper bearing half is in constant contact with the pin. Also watch wear on the lower main bearing half, or it may let the shaft break when an adjacent cylinder fires. Relieve bearings slightly at the sides to avoid gripping, and check after the first 800 or 900 hours to see if they have "run in" right. When pistons are pulled, watch for incipient cracks in the head. If you fit pistons or piston rings poorly, they'll show up in your first overload period in loss of compression, smoky exhaust, increased fuel consumption and fouling in cylinders.

Valve stems may bind if you give them too much or too little clearance. If it's too much, the oil will carbonize and discolor stems, if it's too little, tight fits will show shiny streaks.

Valve roller and cam clearances, if too little, cause loss of power and general bad running. Too much clearance shortens injection and causes noisy valve gear.

DIESEL MAINTENANCE SCHEDULE*

EACH HOUR:

Turn spray and exhaust valve stems a half turn to avoid sticking.
See that all cam rollers turn freely.
Open vent cocks on top of cylinder heads and air compressor to vent jacket space—particularly if reciprocating water pumps with snifting valves are used.
Feel air starting pipe close to heads—abnormal heating shows leaking starting valves.
Record readings of thermometers, pyrometers and gages.
Examine cylinder head joints and air line joints for leaks.
Look for smoke, listen for knocks in housing.
Examine mechanical lubricators and time feed.
Blow water out of spray air or starting air bottles.

EACH SHIFT:

Clean fuel and lubricating oil strainers.
Record readings on oil tanks.
Wipe down engine and clean engine room.

EACH DAY:

Filter one batch of lubricating oil.
Record fuel and lubricating oil consumption.

LONGER INTERVALS: (Max. times given)

On good-sized, medium-speed engines, take indicator cards once in three months.
Take out and clean piston after 6,000 hr. or 12 months.
Clean and grind exhaust valves after 1,000 hr. or longer, depending on fuel and load.
Clean and grind inlet valves after 1,500 hr. or 6 months.
Clean and grind air-starting check valves after 4,000 hr. or 6 months.
Examine fuel-pump plunger after 4,000 hr. or 6 months. Clean and grind valves only if necessary.
Test spray valve tightness every time the engine is shut down.
Check and adjust (if necessary) camshaft gears and chains after 4,000 hr.
Examine governor after 8,000 hr.
Check and adjust wristpin bearing each time piston is removed.
Check crankpin bearing after 3,000 hr. and adjust if slack.
Check main bearings after 8,000 hr. and adjust if necessary, (check alighnment every time crankpin bearings are adjusted).
Check crankshaft for oval journals or roughness each time crankpin bearings are adjusted.
Clean lubricating tanks, lines, passages, after 8,000 hr. or 12 months.
Hunt leaks and loose joints in lubricating oil piping after 1,500 hr., or 2 months.
Clean lubricating oil filter after 2,000 hr., or 3 months.
Examine lubricating oil pump after 4,000 hr., or 6 months.
Examine and clean cylinder head jackets after 4,000 hr., or oftener if water is hard.
Examine and clean cylinder jackets after 4,000 hr.
Exchange batches of lubricating oil after 1,500 hr.
Flush out crankcase after 4,000 hr.
Drain water and oil from air tanks after 200 hr.
*This can be worked up in the form of a log card or sheet with cylinder numbers, dates and remarks on the form.

MECHANICAL DEFECTS—These usually result from bad design, poor machining, or defects in the material. The first two are fairly rare nowadays. Defects in materials may occasionally dodge even the strictest inspection, and usually cause failures without warning. About the only way to avoid trouble is to keep an ear cocked to the sound of the engine and watch the red flags. Even at that you may blame mechanical defects for failures which originated in bad operating practice.

FUEL SYSTEM—Usual failures are at measuring pumps and are caused by dirt and grit in the fuel. Even if the fuel itself is clean, scale or moisture in the lines may clog pumps. Clean fuel strainers or filters regularly and carefully and use duplicate or twin strainers so that they can be cleaned while the engine is operating. After pump suction valves have been reground several times, check timing. Check fulcrum pins and bushings regularly for wear. Be sure that vibration doesn't create bad leaks in your fuel line.

Packed plungers wear and permit leakage, so most modern fuel pumps use lapped-in plungers. These avoid excessive tightening of packing and aggravated wear, but when the plunger wears you will have to replace it instead of regrinding it.

COMBUSTION—Your difficulties here will probably be caused by clogged air inlet pipes (and in the case of 2-cycle engines clogged cylinder parts), cold fuel oil, too low air pressure (in air-injection engines), too low compression (in very cold weather or when bearings have worn excessively so that the piston doesn't rise to proper height), bad valve timing or clogged atomizer disks. Watch your pyrometer readings for the quickest indication of trouble. An abnormal rise in jacket water temperature is also a sign of trouble, but doesn't occur so quickly. If you have an indicator, indicator cards will show late burning and other maladjustments. Light blue smoke at the exhaust shows lubricating oil burning instead of fuel oil, as a result of excessive ring or liner wear.

You may find it hard to isolate the cylinder, and sometimes hard to find the particular element causing trouble. Look for a bad spray valve allowing dribbling, or bad inlet or exhaust valve permitting loss of compression. A well-regulated fuel-injection valve in a solid-injection engine sings a peculiar musical sound tested by working the fuel pump by hand. The sound originates from vibration of the needle valve overcoming spring pressure. A stuck valve can't sing.

Cooling System

COOLING WATER SYSTEM—Air pockets in your water supply lines or in top of cylinder heads may cause failures. Arrange your pipeline without high points and you will avoid the first. Open vent cocks regularly to release air from the heads, and you will avoid the other. Check your thermometers or pyrometers regularly, clean your thermocouples occasionally, and clean water spaces with 10% hydrocholoric acid solution or "Artjel" regularly. (When you do the latter, shut the engine down, close all pipelines, and allow the solution to stand in the engine for 24 to 48 hr.) Don't shut off the cooling water supply as soon as the engine is shut down, because this allows scale to settle out and clog the heads. Condition your water just as you would for boilers, and you will have no trouble with corrosion. Remember that water that's too pure is just as bad as water that isn't pure enough.

On air-injection engines, cooling water is usually passed through the spray-air compressor before it is sent to the engine. If a cooler leaks, high-pressure air blows into the water and stops supply to the cylinders. Sometimes, in excessively damp climates, large amounts of condensation may collect in intercoolers. They should be drained frequently, as should injection-air bottles and starting-air bottles.

LUBRICATION SYSTEM—If you lose forced-feed oil pressure it's probably clogged strainers, excessive clearance in the main or crank-pin bearings due to bad fitting, or bad oil grooves. Loss of pressure may indicate bearing wear before you hear any pounding at all.

Most engines now have separate lubricating systems for pistons and crankshafts to avoid gumming of bearing passages with carbon picked up in the cylinder.

Static or centrifugal filters will save you a lot of grief. Other points to watch are water leaks into the lubricating oil and excessive oiling, which causes sticking rings (if this occurs, feed in kerosene).

SPRAY-AIR SYSTEM AND AIR SYSTEM—Usual troubles result from leaky valves or piping, in the first case, from wear, in the latter usually from vibration. If your spray pressure drops, stop the engine at once to avoid a possible explosion inside the valve body. Air compressor troubles will show up as changes on pressure gages in the low and intermediate stages. Air line obstructions will show up by a rise in the high-stage gage. Check the compressor gages first, then listen for air noises at glands and fittings. Also check valve-spring seating and valve stems for warpage, and be sure lubrication is as low as possible, which is much lower than that for other pistons. If you lose starting air capacity, and have no hand or motorized pump, you can use a tank of CO_2 for starting, but for heaven's sake don't use oxygen or any other compressed gas, or you'll have the whole engine in your lap.

Starting System

STARTING SYSTEM—Usual troubles here are because air pressure gets too low due to several bad starts. Also may be the result of bad timing or sticking of the starting air valves, a compression relief gear out of order, a closed stop valve in the air line, or engaged jacking gear. If your engine won't fire, or runs irregularly, wear or bad fits may be causing low compression, spray valves may be badly timed, or the valves themselves bad. Poor maintenance is usually the cause of all of these. In very cold weather, poor running may be result of excessively low air temperature, particularly in small engines. In this case, turn the engine over several times without fuel injection to permit walls to warm up, or circulate warm jacket water.

Hold cooling water outlet temperature to 130 to 140 deg. on diesel cylinders, 110 to 120 deg. on pistons, 140 to 150 deg. on exhaust lines. Higher temperatures mean trouble. If cooling water is hard, use more of it on the exhaust to hold temperature lower and thus lessen scale deposits, but don't get exhaust temperature so low that the gas drops below its dew point and corrodes muffler and exhaust piping.

VALVE MAINTENANCE—Use a feeler gage to set clearance between rollers and cams at 0.005 in. for spray valve rollers, 0.025 in. for exhaust and inlet valves (4-cycle engines only), clearances to be measured at operating temperature. To keep spray valves tight, keep grit out of the fuel and filter out scale and air in the piping. Leaking valves may be ground in with a mixture of oil and fine carborundum (emery is too coarse). Don't cut too fast, because the fit must be good all around due to the high pressure. Bad cutting of a valve face will require regrinding in a lathe before you grind it in. It's best to inspect spray valves and fuel nozzles with a magnifying glass. Ream your valve seats if they're cut, but fill the reamer flutes with grease to catch and hold chips and avoid later scoring. Check seating by putting pencil lines around, or rubbing the seat with Prussian blue, then turn the valve on the seat a time or two and high spots show up.

Clean spray valves with kerosene every time they are inspected and check valve stems for straightness.

It's good practice to shroud exhaust valve stems to avoid burning or pitting if the manufacturer has not already done so. Grind these valves in with coarse emery, and finish with fine. If you are burning high-sulphur fuel, switch on good diesel fuel for the last few minutes before you stop in order to avoid corrosion from sulphurous acid on exhaust valves.

Some engines have cone-face exhaust valves which are not cooled. These may require grinding every 200 hr. with oil and fine carborundum. Other types require maintenance once in 2,000 hr., with good fuel.

Keep piping cleaned and tight. Watch vibration in the line. Keep exhaust gases above the dew point and exhaust clean and colorless, and you'll have few troubles with your exhaust line. Welding will solve many of your maintenance jobs—see page 190.

Don't forget that almost all manufacturers provide very careful instructions for routine inspection and maintenance of their particular engines. (One will be published next month—a particularly good example). Larger oil companies also maintain research staffs.

The attached schedule is good for plants up to 1,000 hp.; larger ones need more elaborate schedules. They'll have highly organized systems with file cards for each cylinder, routine inspection slips which must be checked by the man making the inspection, probably even a record on the back of each card which shows the cost. Vernon, Calif., has a special maintenance crew.

The schedule as given is purposely too rigid, but follow it until you find where, in your own case, you can cut the corners—but don't cut 'em too far.

DIESEL PLANT SUPPLIES

STORES

Kerosene, gasoline, red lead and litharge (pipe joints) paint, lacquer, linseed oil, turpentine, Prussian blue, cement, packing for spray valves, cylinder heads, fuel valves, pipe lines, etc., braided flax water packing, sheet fibre leather and rubber, cotton wicking, asbestos rope, wool wicking for oil drip cups, gage glasses, wire and cable, electric bulbs and sockets, polish, soap, baled rags.

METALS

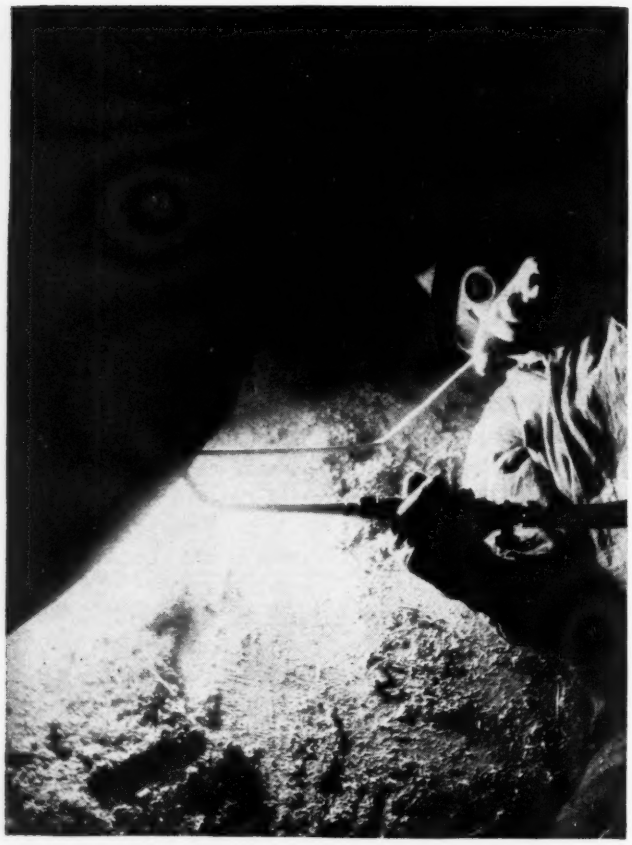
Bar steel, brass and cast iron, sheet lead and copper, sheet tin and iron for shims, laminated shims, lead wire (for taking bearing clearances), wire gauze, bar solder, bolts, nuts, screws, washers, cotter pins, pipe fittings, valves.

TOOLS

Hand, sledge and soft-head hammers, open-end, monkey, socket and Stillson wrenches, bearing scrapers, indicator and cards (for medium and slow-speed engines in good-sized plants), 2-in. micrometer caliper for measuring leads, inside and outside calipers, combination square, hand and electric breast drills, bolt and pipe taps and dies, cutting and welding torch, tin snips, blowtorch, soldering irons, hacksaw and blades, screwdrivers, oil stone, files, cold chisels, surface gage, feeler gage, valve-seat reamer, C-beam clamps, eye-bolts, chain hoist, small blacksmith's forge, punches, gage-glass cutters, gasket cutters, fuel-oil hydrometer, pyrometers and gages, thermometers, emery cloth, powdered emery, fine carborundum, valve compound, mach. oil.

It is also essential in any reasonably sized plant to have a lathe, drill press and grinder, each individually motor-driven and supplied with drills, taps, tools, grinding wheels.

There are, of course, a number of special tools for each type of engine which are supplied by the manufacturer.



Pipe replacement made easy by welding

LEAKY VALVES may not only be a source of considerable waste, but also cause considerable embarrassment when maintenance work has to be done while steam is on the system. Regrind and make tight all riser valves or main branch valves that you know leak.

REDUCING VALVES—Overhaul thoroughly at the end of each heating season. Inspect valve seat and plug for wire-drawing and regrind if necessary. Check operating parts for wear, clean, and put them in first-class condition. Inspect diaphragm disks and replace them if they show signs of fatigue.

DIRT POCKETS—Clean at the end of the first season. After that they need not be cleaned every year, but simply look at them occasionally. One engineer has found it easy to clean all dirt pockets if the heating system is filled with compressed air at 2 or 3 lb. pressure.

PIPE COVERING—Intended to prevent the loss of heat from the heating system to areas where this heat is not required. It also decreases the amount of condensate that main and riser traps are required to handle. If you don't keep it in good repair, these traps may become overloaded, and heating system economy will suffer.

EXPANSION JOINTS—Go over expansion joints. See that they are adequately lubricated, that there is no binding and that the packing is in good condition. If there is evidence of excessive leakage it will probably save trouble next year to take the joint apart, clean it and renew the packing.

HEATING, VENTILATING

THE heating season is about over, so the maintenance season begins. If you've kept a record of all those jobs that should be done when you turn steam off for the summer, next season's heating will probably be more satisfactory, provided, of course, you do the jobs. Just in case you haven't kept such a record, and to remind you of those things that should be overhauled, even though they may not have given trouble, the following check list is presented.

POCKETS—Caused by improper piping. Look for them wherever a radiator has been sluggish or noisy. Usually these are easily remedied and result in vastly improved performance.

LEAKS—Repair them as soon as they occur; don't leave them as a job to be done at the end of the heating season. If the leak is in a line that cannot be shut down without shutting off the steam to the entire building, do the job at night or over a week-end when an interruption of heating service will cause no complaint. Of course, if it's in a very old system, you may justly fear to touch a leaking pipe during the heating season, because of suspected corrosion and the possibility that an entire pipeline may have to be replaced if taken apart.

VALVE-STEM PACKING—Inspect packing on all valves for leaks, particularly those valves that are above hung ceilings, for a gland leak there, although small, may eventually ruin ceiling decorations.

CORROSION—Present in various degrees in all heating systems. The amount of attention that must be given to it of course depends upon how serious the problem may be. Whether or not corrosion troubles have been encountered, it may save you considerable embarrassment during the heating system if you take apart and inspect the piping in some of the places where corrosion is most likely to exist. If you find bad corrosion, replace the pipe and take steps to prevent or decrease the trouble in the future, either by changing feedwater treatment or using different piping material.

LINE TRAPS—When in poor condition, allow high-pressure steam to leak into the return main, and so decrease the vacuum that can be carried in the system. If, as in many systems supplied by steam, the returns are discharged to the sewer, the direct loss of heat is serious. It will probably pay you to overhaul all main and riser traps during the summer months.

RADIATOR TRAPS—If known to be leaking, repair them at once. It isn't easy to find leaky traps, particularly in buildings where a large number of radiators are connected to a single riser. Many engineers of such buildings have instituted a regular routine of overhauling all radiator traps, regrinding seats and plugs, and dipping the operating parts in oil to preserve them during the non-heating season. When trap parts are beyond repair, replace with new. Modern trap parts,

in the case of most traps, may be installed in old bodies with minimum work.

RADIATOR SIZE—Particularly in new buildings, may be found too large or too small. Remedy this condition during the heating season, as everyday use of a radiator of too great capacity means wasted steam, while of too small means discomfort to the occupants.

UNIT-HEATER LOCATION may have been found to cause undesirable drafts or not to give proper circulation so that parts of a building are left unheated. If possible, make such changes during the heating season so that the new location can be given a trial.

UNIT-HEATER MOTORS—Clean, inspect and clean bearings, and renew oil. Inspect and clean the automatic starting switch contact. Overhaul and clean the condensate trap on the heater so that it is in first-class condition.

VACUUM PUMPS—Overhaul them. Inspect, clean, and change oil on both pump and motor bearings. Inspect float-starting switches and clean electrical contacts. Remove the top half of the casing and inspect the runner for corrosion or wear. Take out and clean pump strainers and clean the receiving tank. If a pump is of the reciprocating type, inspect pump valves and renew packings; otherwise they may harden during the summer season and score the rod when you start the pump in the fall.

CONTROL EQUIPMENT—Depended upon to produce economic heating. Inspect it thoroughly during the summer, and clean and overhaul all moving parts. Test remote temperature indicators for accuracy and repair if necessary.

BOILERS—Maintenance is treated in greater detail on page 173 of this number. Boilers used for heating steam only must be properly laid up for the summer season. Clean them very thoroughly first. It is good practice to coat the drum with graphite or other protective material, and to fill the boiler with water before leaving it for the summer. Leave dampers closed and put slaked lime in the furnace to absorb moisture and so decrease the amount of rusting.

Air-Conditioning Maintenance

AIR WASHER—Clean tanks and strainers thoroughly. Give tank and eliminator plates a coat of corrosion-resisting paint.

SPRAY HEADS—Remove and clean all sediment from them. Replace spray heads that have corroded to such an extent that the spray is interfered with.

AIR WASHER PUMPS—Overhaul, inspect bearings, and renew oil. Open up the pump and inspect the impeller for corrosion or wear.

MIXING VALVES—Inspect and regrind if pitted or cut from wire-drawing, and clean moving parts so that they will operate freely.

FANS—Usually require little maintenance other than cleaning bearings and renewing oil in both fan and motor. If a flexible coupling is used between motor and fan drive, inspect it, and if it's of the lubricated type, clean and put in new lubricant.

DUCTS AND GRILLES—Clean as much as possible. Obviously, you can't clean all the duct-work, and it isn't likely that it need be done very frequently. However, it is not well to allow a great deal of dust to collect either in the inlet or outlet grilles.

DAMPERS—Inspect to see that they move freely so that the control equipment will operate them without difficulty.

CONTROLS—Usually need cleaning and some adjustment after a season's operation. If they are badly out of adjustment, it may be advisable to employ the services of a factory representative to do a thorough overhauling job.

REFRIGERATION COMPRESSORS—Give periodic overhauling and inspection at least once a year. Work that must be done depends entirely upon the type of machine installed. If of the reciprocating type, inspect valves for wear. Check, clean and put new oil in bearings. Repack stuffing boxes if fibrous rings are used. If stuffing-box leakage is a constant occurrence, check alignment of the piston rod and consider the possibility of using any of a number of metallic packings. Inspect and clean driving motor, and, if mounted on the compressor shaft, check uniformity of air gaps. If this is not uniform, readjust the shaft.

and AIR-CONDITIONING

CONDENSER—Cleaning is the usual maintenance work required, but check carefully for corrosion. If you find mild corrosion, it may be retarded by painting on the water surface. If you use water from a cooling tower, use chemical treatment to prevent corrosion.

COOLING TOWER—Clean thoroughly and paint the basin with hot asphalt or other corrosion-resisting paint. Inspect all wooden parts of the tower and if you find any deterioration treat with wood preservative. If the tower employs spray heads, inspect and clean them.

EXPANSION VALVE—Should not leak. If on inspection you find pitting, regrind the valve seat, disk and plug.

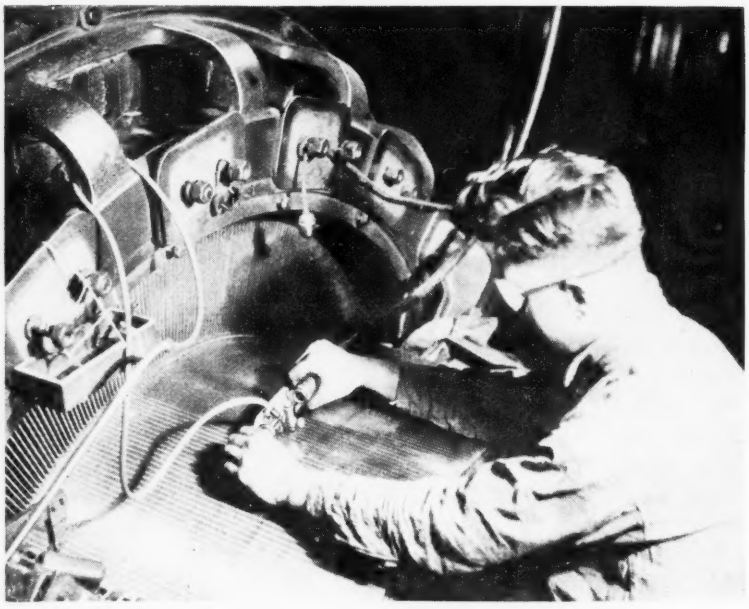
WATER COOLER—Inspect in the same way as the condenser.

WATER STORAGE TANK—Clean and coat with a corrosion-preventive paint.

CIRCULATING PUMP—Inspect and overhaul as indicated for other types of pumps. (See paragraphs.)

AIR FILTERS — Inspect, clean, and, where necessary, renew the filtering material. Make this inspection regularly, as indicated and advised by the manufacturer, and by experience indicated by the amount of dust in the air.

ELECTRICAL EQUIPMENT



Under-cutting commutator mica prevents trouble

A WELL-ORGANIZED and efficiently operated maintenance department pays big dividends in any industry. There are many reasons why this is so: If equipment is systematically inspected and kept in repair, little faults will be located and corrected before they cause unexpected failures, prolonged breakdowns and expensive repairs. Loss of production is frequently the most expensive part of an unexpected shutdown. Uncertain operation of equipment tends to disorganize production methods and increase operating costs.

The basis of good maintenance is an adequate system of inspecting and repairing the equipment periodically and for recording pertinent data regarding performance. Give every motor and its control a number. Clean and check lubrication on every motor once a week. Make routine tests for loads and keep a record of them. How frequently an inspection should be made is a guess to start with. Motors and control equipment operating under severe conditions require more frequent attention than those more favored. Make inspections frequently enough to detect signs of impending failure before they have time to cause a shutdown. An unexpected failure shows that your methods require changing.

Protection and cleanliness are paramount. Lack of protection has caused very expensive repairs. In careful cleaning, you'll find and correct little defects before they develop into serious and unexpected trouble. The man who cleans a motor should also take care of lubrication, belt adjustments, report unusual temperature rises in winding and other conditions that affect operation. Then, if a failure occurs, responsibility is fixed.

Make insulation-resistance tests periodically; frequency will depend upon operating conditions. But under best conditions, test insulation annually and keep a record of the readings. What is good insulation is a moot question. It is generally agreed, however, that the insulation resistance should not be less than one megohm. In many plants three to five megohms is the minimum insulation resistance requirement. When insulation gets below requirements, take the equipment out of service at the first opportunity, clean it thoroughly then dry it out until the required insulation-resistance value is established. While the machine is hot, give it a good coat of insulating varnish, either by dipping, painting or spraying.

In some plants where motors have to operate in the presence of graphite dust or other conducting substances, the motors are thoroughly cleaned annually, or more frequently, dried out and a coat of insulating varnish applied. This practice in some plants has eliminated winding failures.

In plants operating seasonally, all motors are cleaned, conditioned, and given a coat of insulating varnish during the off season. Where motors are to be shut down for a considerable period it is good practice to thoroughly clean them, and while they are hot apply a good coat of insulating varnish to the windings, by some one of the methods previously mentioned.

Care should be taken to protect insulation against oil. Experience has shown that from 50 to 90% of motor-winding failures are caused by oil getting on insulation. Anti-friction bearings are designed to keep lubricant in the bearing and dirt out. These bearings have done much to eliminate winding failures. Old-type sleeve bearings should be sealed with felt washers or by other means to prevent lubricant from getting onto the windings.

When you inspect motors, watch the air gap between rotor and stator. This is particularly important on alternating current motors with short air gaps. Check brushes on slip rings or commutators, for wear, freedom of brushes in holders, condition of brush shunts and their connection to the brushes and holders, brush alignment with commutator bars, spring tension on brushes and keep brush-holder, commutator and slip-ring insulation clean.

Undercut commutator-bar mica and keep the commutator surface in good condition. How the latter is to be done will depend on conditions, but as long as the commutator surface remains smooth and a chocolate color, it should be cleaned only with a piece of canvas. When the commutator surface becomes rough condition it with a hand stone. If this is not sufficient, use a grinding wheel or a stone held in a lathe-tool rest.

A wide variety of tools are available for undercutting commutator micas. These vary from special hand files to several types of power-driven tools. For cleaning where compressed air or a permanent vacuum system is not installed, portable blowers and vacuum cleaners are available. Portable grinding and polishing wheels, portable drills and compressed-air varnish sprayers may be had. A wide range of testing devices for measuring insulation resistance, locating faults in machine windings, making load tests, locating circuit faults and other equipment are available to help make the maintenance easier and more reliable. The use of meters for making tests in maintenance work is discussed on page 185.

Control equipment must be given just as careful attention as its motor or generator. Many controls have a multiplicity of small contacts. If any one gets out of adjustment or dirt gets in, you may have a shutdown. Even though these equipments are designed so that they normally give little trouble, eternal vigilance is the price of uninterrupted service.

Manual-type starting compensators usually have oil-immersed contacts and cannot be inspected without dropping the oil reservoir. This should be done frequently enough to insure reliable service. Also: File and dress contacts to put them in good condition. Replace thin and defective contacts. Change oil once per year if service is heavy, or oil gets dirty or carbonized.

Examine all terminal studs and nuts for looseness and make sure that all connections are tight. Look for evidence of loose or hot contacts, the latter being indicated by discoloring of the metal. Check operating lever and mechanism to see that it functions properly. Check action of under-load and under-voltage releases and make adjustments if necessary.

The following suggestions will be helpful in laying out inspection schedules for control equipment:

Have a regular inspection system and follow it closely. Keep records of repairs and their costs; it may be cheaper to junk certain equipment than to keep it in repair. Keep necessary renewal parts in stock. Keep all contacts clean, properly adjusted and in good condition. If there is any doubt about the serviceability of a part, renew it.

Renew contact shunts when they show signs of failing. Make sure that shunts have good contact at both connections and that the connections remain tight. Rolling-type contacts, if used frequently, usually wear to a good surface and do not require cleaning.

See that contacts meet for the full width of their surfaces. Do not operate a new rolling contact with an old one; renew both to insure satisfactory service. Test spring pressure on contacts each time the controller is inspected; sometimes high temperature destroys spring tension quite quickly. Periodically, with a spring balance, test contact-spring tension with contact closed.

On controllers having rubbing contacts, such as drum or face-plate types, wipe contacts clean and then use a little vaseline to lubricate the wearing surfaces. Make sure that contact pressure is sufficient to insure good electrical connection between moving surfaces, and yet not cause unnecessary wear. After lubricating and operating a few times wipe off excessive lubricant.

Adjust contacts on drum controllers so that they drop about $\frac{1}{8}$-in. when off the drum segments. When sliding contacts are open, such as on face-plate controllers, they should not be lubricated if exposed to abrasive dust, but operated with minimum pressure.

Two sides of a card for keeping record of motor and control equipment

H P.	Syn. Speed	Make	Winding Diagram	Application	Shop or Mill No.	Card No.

Type	Frame	Poles	F. L. Speed	Volts	Form	Temp. Rating	F.L. Amp.	Phase	Cycles

Serial No.
Model No.

Publication No.

CONTROL EQUIPMENT

Type	Make	Pub. No.

BRUSHES
No. Per Motor
Cat. No.
Size
Material
Grade

LININGS
Front End, Cat. No.
Pulley End, Cat. No.

COILS
(Cat. or Spec. No.)
Stator or Field
Main
Comm.
Comp.
Rotor or Armature
Coils
Bars
No. per Set

Connection Diagram

PULLEY
Diam.
Face
Belt Width
Bore
Keyway

Mfr's Order No.
Our Order No.
Date of Order
Cost { Motor / Control

User:
Location:

REMARKS:

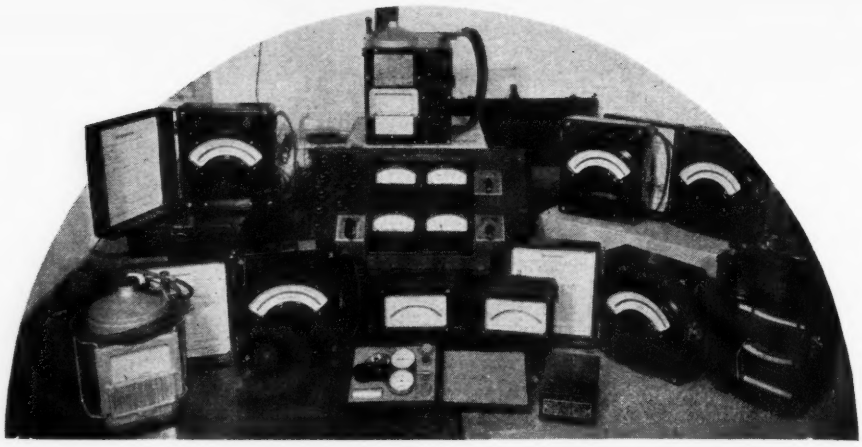
THIS RECORD CARD FOR MOTOR USERS is recommended for stock and inventory, repair motor part, motor transfer, required power, service and similar records. Furnished by General Electric Company. SMD-39 50m 6-26-25

SERVICE RECORD

Date	Building	Floor	Driving	Drive	Tested Hp.

REPAIRS

Date	Condition	Due to	Repaired by	Cost



Portable meters used in maintenance by one plant

METERS IN MAINTENANCE

METERS, recognized operating essentials, are not so generally recognized as necessities in maintenance. Actually, meter uses in operation and maintenance are so closely interwoven that it is difficult to differentiate between functions. Here we're going to try it, however, stressing maintenance uses primarily.

It's hard to see inside a motor, an engine, a turbine—but meters can do that job for you. Visual inspection will show any surface condition which may cause trouble, but it takes meters to show loss of efficiency, improper adjustment, and the internal conditions that indicate trouble to come. If they're caught while they're only indications, there'll be no sudden breakdown.

Steam flow and coal weight are essential in knowing boiler performance and in analyzing costs. They also indicate a boiler's condition without requiring that it be taken out of service. Other boiler meters recording draft and temperature, likewise tell a valuable story to the maintenance man on a still hunt for incipient trouble. Steam-flow and kilowatt-hour meters on power-generating units show steam chargeable to the unit and power produced at any given time, and they'll also tell how efficiently the machine is being maintained—if you record readings regularly. If you are able to balance power loss and increased steam consumption (due to decreased efficiency) against the cost of reblading the turbine, you can estimate the most economical time for making repairs.

Resistance thermometers in windings of medium and large-size electrical equipment will show you safe loading and when the machine should be stopped for cleaning windings and ventilating ducts. This information can't be obtained any other way, because iron and end winding surface temperature readings do not show hot-spot temperatures—the real danger zones in windings.

A conductivity meter in a condenser hot well will tell you about condenser leakage and when the condenser should be overhauled. A vacuum gage on the condenser and a thermometer in the circulating water tell a pertinent story on how clean the condenser is and when it should be cleaned.

Meters on electrical, steam, water and other services to a plant department give information necessary for production and accounting, but also show hidden defects in equipment that you couldn't see even if you looked for them. Flowmeters, temperature recorders, and pressure gages on automatically regulated steam lines are essential in showing condition of regulating equipment and how efficiently the service is being used.

Permanently installed watt-hour and other electric meters record power consumption, but, beyond that, a gradual increase in pump power consumption shows up decreased efficiency and gives you a basis for determining when the pump should be overhauled.

Here is one illustration of how watt-hour-meter readings may reveal hidden defects in equipment. Power taken by a rotary air compressor gradually increased. A check of outside conditions revealed nothing. When the compressor was opened, the rotor was found rubbing the casing. The repair was cheap, but for the watt-hour meter and careful records of its readings, the fault probably wouldn't have been detected until costly damage had been done—in addition to large power losses over a long period.

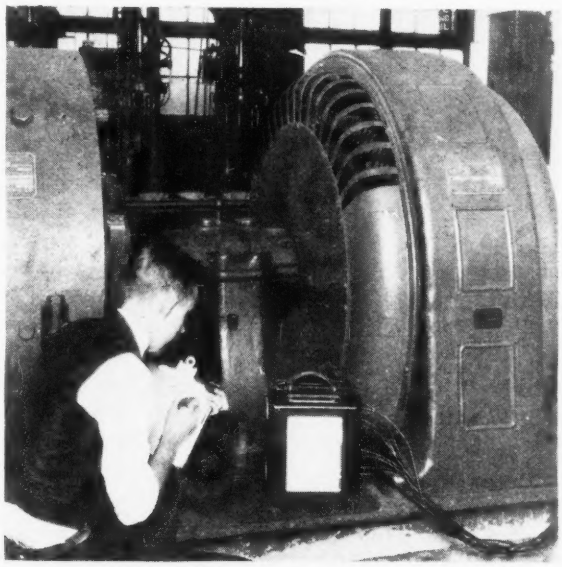
Again, during an unusually dusty period, power consumption of some blowers increased rapidly. A search for the cause showed the intake screens stopped with dirt. Here again the watt-hour meters gave warning of a fault that probably would not have been located for a long time otherwise.

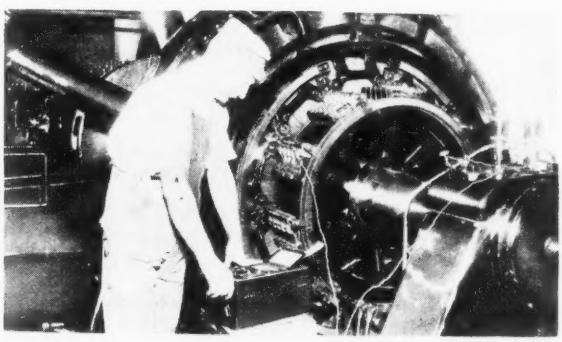
Watt-hour meters, stop counters and car-mileage records on elevators all provide information to indicate when faulty conditions exist and give other valuable data.

On some classes of equipment, such as cement kilns, power loads may increase very rapidly due to misalignment. A wattmeter or an ammeter on the driving motor will reveal this condition as soon as it begins to develop. Without the meter, time may be wasted checking alignment when it is not necessary, or not checking when it should be done, with resulting

large power losses or a burned-out motor due to overload. Where loading a motor is a matter of machine adjustment in the hands of an operator, an ammeter in the motor circuit is a valuable guide when adjusting the machine. Where frequent trouble with burned-out motors has been experienced, the trouble has been corrected by installing an ammeter or wattmeter to guide the operator in making adjustments of the machine.

Top—Recording wattmeter load tests give valuable data on motor and machine performance. Center—Megohm-meter insulation-resistance tests indicate defects that cannot be found by visual inspection. Bottom—Watt-hour meter readings are a guide to machine efficiency and condition





In addition to permanently installed meters, a wide variety of portable meters will help you in maintenance work. One is a motor analyzer that comprises a polyphase wattmeter, a voltmeter to read voltage of each phase, an ammeter to check current in each phase and a power factor meter all mounted in a case with suitable transformers, connections and switches. It includes all elements for analyzing a motor load, yet is portable. A recording wattmeter and a recording power-factor are important in load studies and detecting faults.

Megohm meters to check insulation resistance of machines and circuits, direct-current voltmeters and ammeters with suitable resistances and shunts, alternating-current voltmeters and ammeters with multiple-ratio potential and current transformers; clamp-on type ammeters; tachometers; recording thermometers and other metering equipment have a place.

Insulation is the vulnerable part of every electrical machine. Its quality is affected by heat, moisture, oil, dirt, acid, sulphurous and other fumes, mechanical stresses and so on. Obviously, a close check should be kept of its condition. If insulation is kept clean and dry and given a coat of good insulating varnish periodically an important part of the job of keeping it in good condition will have been done. Even when this is most scrupulously done, defects may develop that are not apparent. By megohm-meter tests these can be located before they cause unexpected breakdowns.

Voltage and Current

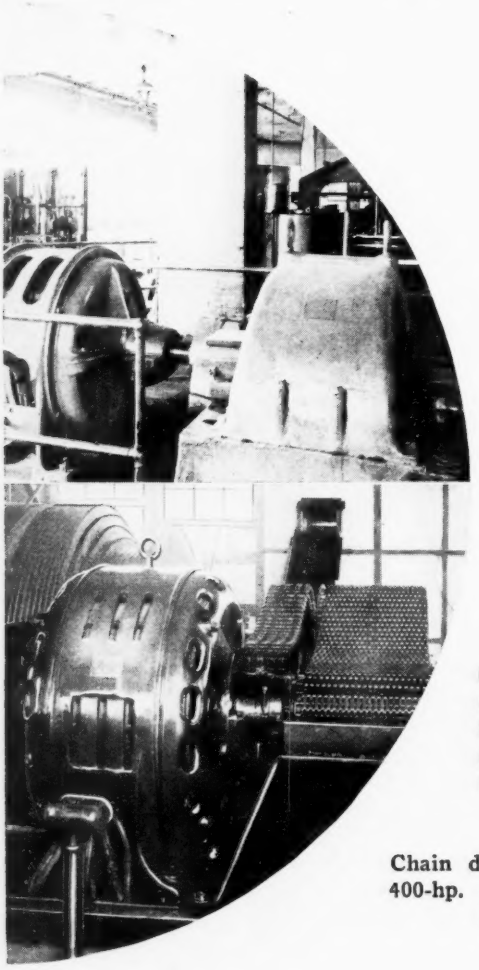
Periodic load, voltage and current tests are also essential, and a record should be kept of them. This is particularly true on alternating current motors. Not only overloads, but voltage and current balance may affect their operation. The torque of an alternating-current motor varies as the voltage squared and, unless the voltage is held fairly close to rated value, it may adversely affect motor operation.

Unbalanced phase current indicates unbalance in voltage or in motor windings. For example, if a stator winding were connected two-parallel star and one of the windings were to become open circuited, this motor would start, and, if not too heavily loaded, operate; but one phase has one-half winding only. A check of current in each phase, such as can easily be made with a motor analyzer, will indicate such conditions by showing unbalanced current.

High temperature in electrical equipment, like fever in a human being, is a symptom of trouble. Therefore several thermometers should be part of the maintenance equipment and inspectors should be taught to use them.

A great advantage of meters in maintenance work is opportunity given inspectors to become acquainted with machines and their performance. Until machines are thoroughly understood, those responsible for their care cannot do a 100% job ferreting out causes of pending trouble, which is the criterion of good maintenance practice. The best argument for organized maintenance methods and meters in this work is that when machines are regularly inspected and tested, maintenance costs are lowest and equipment is most reliable.

POWER TRANSMISSIONS



Gear speed reducer connects 250-hp. synchronous motor and its load

Chain drive connects 400-hp. motor and hoist

"NO CHAIN is stronger than its weakest link." Old saw this may be, but it still is very true. Mechanical power transmission equipment forms the connecting link between motors and loads, hence must, in an inspection and maintenance program, be given attention equal to that given the motor and control.

Because of the wide variety of mechanical transmissions used, no general set of rules can be formulated for their inspection and care, therefore, some of the important types are considered individually.

FLEXIBLE COUPLINGS—Frequently abused because of their simplicity and a mistaken idea that they can operate continuously with equipment out of line. When a solid coupling is replaced by a flexible type, a machine with moving parts is substituted for a solid mass. Like any other machine, the more it has to work the greater will be its wear. Excessive misalignment creates unnecessarily high wear on the coupling. Where excessive misalignment must be taken care of, a double coupling combination or a universal joint is better.

The first step in coupling maintenance, just as in maintenance of other equipment, is selecting one suitable for the job. Some types of couplings are designed to operate in an oil bath. In these, maintain proper oil level and about once a year renew the oil. Watch couplings for signs of excessive wear or other forms of weakening, and if you find them, correct them before failure occurs.

LEATHER BELTS—Belts often operate in the open and are frequently subjected to other adverse conditions. Watch for these and correct them before they have an opportunity to cause excessive wear or complete failure. When you select a belt make sure it is suitable for the application; then here are some of the things to consider in its care:

See that proper tension is maintained. Run the belt as slack as possible and yet avoid slip. Where possible, operate the belt with the slack side on top. Don't operate belts on under-sized pulleys. Keep belts clean and prevent them from becoming oil soaked. Clean and dress the belt regularly with a good belt dressing, every 6 months for the first year and at 3-month intervals thereafter. Do not use sticky dressings, they destroy the belt. Always operate belts with grain or hair side on pulleys. Use endless belts whenever possible. Run a belt so that the feather edges of laps on the side next the pulley will point away from the pulley as the laps approach it.

Be sure a belt is properly squared and lined up before making a splice. When using belt lacing or other types of belt fasteners, make sure that the belt ends are cut square and that they line up when fasteners are applied. Renew fasteners when they show signs of serious wear; worn fasteners cause joints to break and tear. Watch belt for laps that start to open and cement them down immediately.

If the belt does not run correctly on the pulleys, find the cause and remove it. Do not let the edge of a belt run against any object. Avoid shifters that do not throw the belt entirely on or off the loose pulley, as one side of the belt will be stretched more than the other and will run crooked. Do not run belts on flat-faced pulleys unless they are on a shifter drive. Avoid idlers where possible; they put a reverse bend in the belt. If idlers must be used, select an approved design, generally gravity type, and install it according to recommended practice.

Do not let oil or water drop on a belt. On short-center drives use motor bases that automatically maintain correct tension in belts. Do not overload belts. Keep records of belt performances and study these records for cause of unsatisfactory service.

RUBBER BELTS—Many of the rules given for leather-belt inspection and maintenance apply to rubber belts as well. These include proper tension, size of pulleys, keeping belt and pulleys clean, avoiding oil on the belt, making joints in belt and inspection of fasteners, conditions of pulley and shafting, use of idlers and belt shifters, rubbing of belt edges, and motor bases to maintain tension automatically in belts on short-center drives. Here, however, are features that apply to rubber belts only.

You can now readily make rubber belt endless on the job, where such belts can be used and where factory-made endless constructions cannot be applied. Use belt dressing on rubber belts to soften the surface slightly so that it will press onto the pulley more completely. Use dressings approved by belt manufacturers.

Watch for causes of ply separation, or blistering, that may be caused by lumps on pulleys. Keeping the pulleys clean will do much to avoid this trouble. If a blister starts, a lengthwise slit through it to release the air will sometimes stop the blister and permit the belt to operate for a long time without further damage.

Belt Fasteners

Use the correct type and size of fasteners to join belts that have not been made endless. Fastener failure may be caused by improper size and type of fastener, belt too tight, pulleys and shafting out of line, idlers and reverse bends, lumps on pulleys, belt weakened by punch holes and pulleys with excessive crown.

In general, run folded belts with the seam on the outside, but on a pulley with excessive crown it may be advisable to run the seam on the inside. Oil on the belt disintegrates the rubber seaming strip and destroys its adhesion to the fabric.

Flanged pulleys should be carefully aligned to prevent excessive wear on belt edges due to rubbing on the flanges.

Avoid excessive slippage of belt, which is evident by highly polished surfaces on pulley and glazed surfaces on the inside of the belt. Excessive slipping will cause rapid wear of the inside ply.

MULTIPLE V-BELTS—No amount of attention can make a poorly designed drive give good service. Trouble may be encountered because an insufficient number of belts are used (overloading the drive), sheave diameter is too small for belt cross-section, sheaves have incorrect groove angles, belts run at too high a peripheral speed, and belt construction is wrong for a given application.

Do not use V-belts where the temperature is over 120 deg. F. continuously. Don't let oil get on the belts and sheaves. See that sheave grooves have an angle so that the belts take the load at their pitch line. Don't allow belts to bottom in the grooves, for they'll lose traction, slip and generate heat.

Keep grooves' side-wall surfaces smooth and their outer edges rounded slightly, so that they are free of sharp corners that might cut the belt. Rough surfaces may be caused by poor machining or rusting.

When you store sheaves, keep them well coated with a neutral grease to prevent rusting or pitting. When you put them back into service, clean them thoroughly.

When a drive is to stand idle for a long time, remove the belts, store them in a cool place and protect the sheave grooves with a coating of neutral grease. See that all belts are loaded equally. All grooves must be the same size and the belts must have equal cross-section. Unequal loading of belts may be caused by one belt stretching more than another, unequal wear of belts or sheave grooves, dirty belts and grooves.

GEAR REDUCERS—Most gear drives are now built as a unit and operate enclosed, so that if they are not overloaded, are kept in proper alignment with load and motor, and are properly lubricated they should give little trouble. Where gears run in an oil bath, don't let oil level get too high, or the gears will act as a pump, reducing their efficiency and heating the oil. Open the gear case at least once a year, remove the oil, wash out gears and casing thoroughly, and put in new oil of a correct grade.

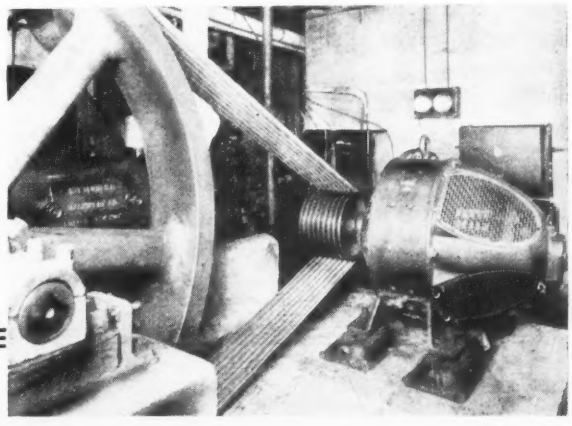
CHAIN DRIVES—What has been said about gears applies very largely to chain drives. For lubrication of chain drives see page 118 of the March number. It is advisable to enclose chain drives entirely as this keeps dirt and dust off the chain and simplifies lubrication.

Keep sprockets and shafts in proper alignment. See that float of motor shaft does not tend to throw sprockets out of alignment. If guide links wear on one side, sprockets are not in line. Maintain proper slack in the chain. On long-center drives, do not let chain get so slack that the top strand rubs on the bottom one.

Do not put a new chain on worn sprockets, or a worn chain on new sprockets. Keep sprockets tight on shaft. Don't allow accumulations of slack that permit the chain to slip. Abnormal sprocket and chain wear is an indication of misalignment, lack of lubrication or improper meshing of chain and sprockets.

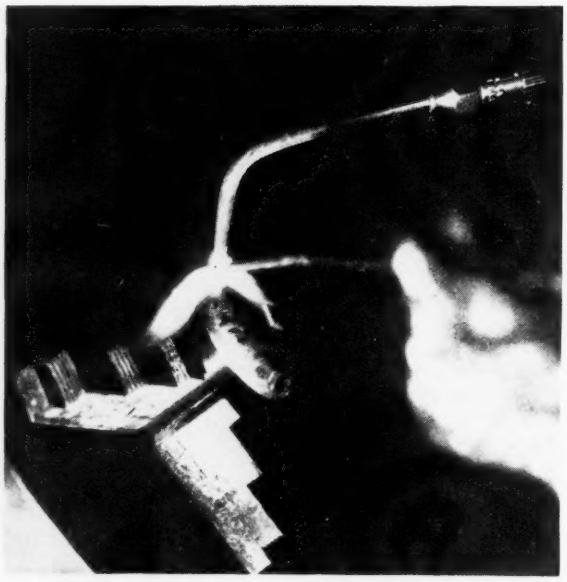
VARIABLE-SPEED TRANSMISSIONS—Variable-speed transmissions are made in such a variety of types—such as friction disks, flat belt or cone pulleys, V-belts on V-pulleys, cone shaped rollers, variable-throw eccentrics, and hydraulic—that general rules cannot be laid down for their inspection and maintenance. Many instructions, however, given for other types of equipment apply to variable-speed transmissions. They must be selected of a size suitable for the drive to which they are applied and protected against unfavorable operating conditions.

Multiple V-belt connects direct-current motor to CO_2 compressor



TORCH, ARC & SPRAY

Welding, hard facing and metal-spraying all will save you dollars in time and maintenance labor



Stelliting a 3-in. disk for a 600-lb. check valve

ALMOST an old timer among power maintenance tools now is the oxy-acetylene cutting and welding torch, or blowpipe. From sump to roof, wherever there are metal parts needing maintenance, this tool has found a place. The electric arc, common production tool, lacks an associated cutting method and flexibility, but it has the advantage that certain jobs require no preheating. While much more expensive than the gas equipment, it is being used in many central stations.

Just gaining application and prominence is the metal-spraying process. As understanding of its technique and uses grows, it bids fair to share the honors with welding as a universal maintenance tool.

Welding has found its place in repairing every metal part from sprockets to cylinder heads, from piping to tool racks. Steam engine or diesel cylinder heads are commonly repaired by welding, as are broken crankshafts, split pipe sections, leaking joints, cracked frames, broken flywheels and sprockets, motor frames, pistons, pitted pump impellers, pitted waterwheels, leaking tanks, and so on, as long as it's metal. These are primarily joining jobs, but there are also applications such as building up worn surfaces on cams, shafts, screw threads, couplings and clutches, bearings, gears, pulleys, sheaves, drums, cylinders, liners, jackets, heads, pistons, turbines, impellers, rotors, conveyor parts.

Then there are specialized uses, such as preheating in replacing bearings, heating for shrink fits, normalizing, and so on.

These lead more or less naturally into hard surfacing and bronze welding, the first to produce an abrasion-resistant surface, the second to join cracked or broken castings or to produce a sliding or bearing surface. Hard surfacing has been applied to valve seats and inserts, building up stoker sprocket teeth, stoker dogs, gate and globe valve faces and seat rings (particularly on soot-blower master stop valves), in fact wherever a surface almost glass-hard is required. Valve seats so protected have not been cut after two years of severe service, in fact general application has been so successful in this use that some manufacturers are supplying new valves with hard-faced seats and mating faces.

Commonest of the hard-facing materials is Stellite, a non-ferrous cobalt-chromium-tungsten alloy, recently introduced into high-temperature steam service successfully. Less hard is stainless steel and various high-carbon steel alloys, usually welded on instead of being "flowed" over a preheated surface as is Stellite. A hard alloy for application with the arc has just been introduced. (See arc-welding in maintenance article in May).

Bronze welding is an interesting application of a dissimilar metal on almost any base metal. Here is a material used for sliding or mating surfaces and surfaces to resist corrosion. It is extensively used in building up worn valves and pump plungers, pistons, shafts, but mainly for mending incipient cracks in frames and cylinder heads—as long as operating temperature stays below 500 deg. F. Cast iron surfaces can be bronze-welded as often as your heart desires, but better limit bronze welding of steel surfaces to once or twice, because several applications cause surface checking of the steel due to penetration of the bronze between the grains of the steel structure. A good bronze weld will hold pressures to 1,000 lb. per sq.in. and more, so the process has been used in repairing cracked diesel frames, cylinder heads, compressor valve caps and so on. It is cheaper and faster than welding proper, and permits repair of cast structures without bothersome preheating and possible cracking or heat distortion due to release of pent-up strains. A new "H.S." bronze rod will give tensile strengths up to 60,000 lb. per sq.in., and has done much to advance this method of mending.

More will soon be heard from the process of spraying molten metals, whose possibilities have not yet been tapped by power operators. The sprayed-on coating sticks through mechanical bonding, not welding, so is useless for repairing cracks and high-temperature work, but for building up worn surfaces with any of a dozen metals, producing an abrasion-resistant or heat-resistant area, or combating corrosion, it has many uses.

With proper development and application where it is best suited, there is no reason why this tool should not work hand in hand with welding—welding to handle the high-temperature, hard-surfacing, mending and joining jobs, spray to handle rebuilding or protecting of large areas. In fact, the two processes can be used together on such jobs as building up pump plungers or diesel pistons, welding handling the heads or ends where maximum pressure or temperature is encountered, spray covering the larger wearing surfaces.

In General

IN THE preceding articles, most of the major power maintenance problems have been discussed. These articles have of necessity been general, for a good-sized library wouldn't even begin to answer adequately all your specialized problems. There are, however, dozens of maintenance pointers in *Power* each month, special ones in the Practical Aids to Operation and Readers' Problems departments, general ones in feature articles. Some of the more comprehensive articles are listed in the bibliography below. 1001 of the best operating and maintenance tips among the practical letters during the last few years are soon to be published in the *Power Operator's Guide*.

There are also pointers in technical papers of such societies as the A.S.M.E., and the A.I.E.E., in reports of the Edison Electric Institute, and in bulletins of various manufacturers. Five years ago, (Aug. 26, 1930) *Power* devoted an entire number to maintenance, two months ago (Feb., 1935, p. 88) the Piping Section included a maintenance story.

Valve maintenance is vitally important, but it is a specialized problem varying with types, plants and localities. You should inspect all valves regularly and of course repack and reseat when necessary. A number of tools are available for reseating, and valve manufacturers will tell you how to maintain their particular types of valves. And let's not forget housecleaning—it's more important in the plant than it is at home, for if you forget cleaning you'll have trouble with dirt in everything from bearings to instruments, you won't find the defects that dirt hides, and even plant morale will slip away. Wipe up and sweep down at least once a day; go through a regular housecleaning once a week. (A portable or installed vacuum cleaning system may be a worthwhile investment). Don't neglect windows and don't forget the virtues of the paint brush. It's not our place to talk like a Dutch uncle, but painting will do more to snap up the appearance of your plant than any other single thing. For types and kinds of paint look back over these three articles: "Power Plant Painting," April and May, 1934, and "Some Observations on Paint" by Hartley in October, 1934.

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Operating and Maintaining Diesel Engines—Porter (Sept. '34, p. 522)

Are Your Diesels Maintenance Hounds?—Thayer (Dec. '34, p. 667)

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Hot Spots in Diesel Operating Logs—(Nov. '34, p. 618)

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Safety With Diesels—Maleev (March, '34, p. 142)

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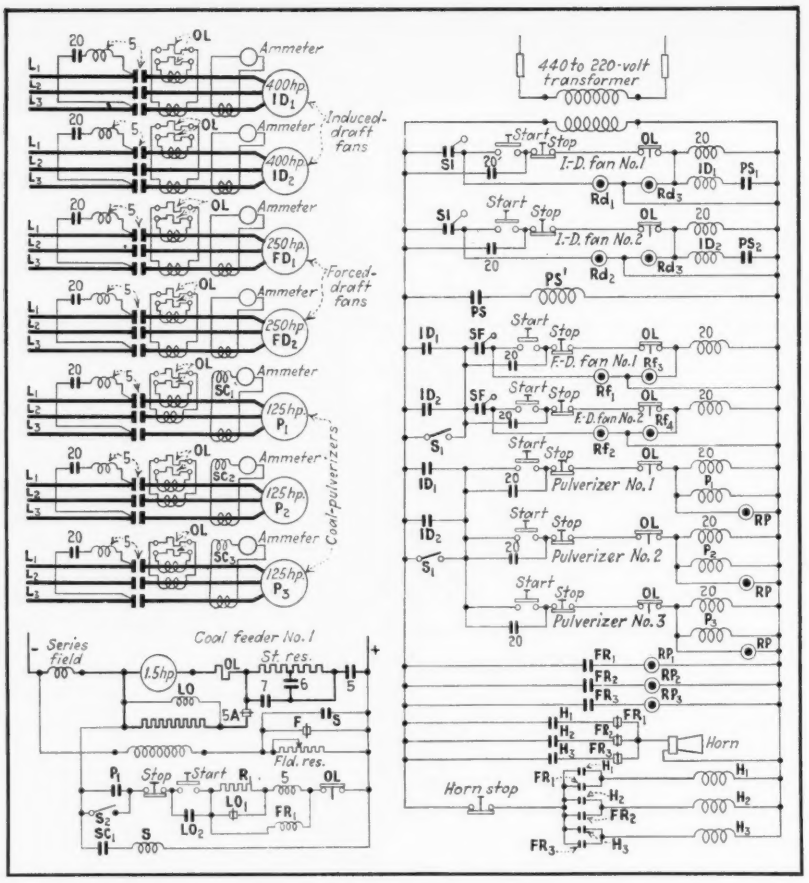
Welding and Metal Spray

Hard Surfacing Valves for H. T. Steam Service—Mar. '33, p. 110. Welding—Handy Power Plant Tool—Nov. '34, p. 620. Bronze Surfacing in Power Plant Maintenance—Greene, Aug. '34, p. 448. Builder Upper (Metal Spraying) — Tangerman, Dec. '34, p. 661. Lowdown on Sprayed Metal Coatings—Mar., '35, p. 143.

Simplified diagrams of controls for fan, pulverizer and feeder motors

Electrical interlocks protect the new W. Va. Pulp & Paper Co.'s boiler at Covington preventing improper starting of draft fans, coal pulverizers and feeders, and by shutting down equipment when trouble develops



WATCHMEN for COMBUSTION EQUIPMENT

CONTROL of West Virginia Pulp & Paper Co.'s new boiler at the Covington, Va., plant, described in February *Power,* is practically automatic. The boiler is rated 375,000 lb. of steam per hr. at 608 lb. gage and 725 deg. F. total temperature. It is equipped with two vane-controlled, induced-draft fans driven by 400-hp. motors, two vane-controlled, forced-draft fans driven by 250-hp. motors, and three pulverizers driven by 125-hp. motors. These motors are constant-speed, squirrel-cage type, arranged for across-the-line starting. Three burners, one per pulverizer, each has a feeder driven by a 1.5-hp. d.c. motor.

All auxiliary equipment is started and stopped from the automatic-control panel. To insure proper handling of equipment by the operators, several safety features have been installed in the control. To keep starting current at a minimum on the motors, fan intake dampers are closed while fans are started and accelerated. Switches controlled by damper position prevent starting a fan unless its damper is closed. Interlocks in the control circuits require that an induced-draft fan be running and its damper open before a forced-draft fan or a coal pulverizer can be started. A pulverizer must be running before its feeder can be started. Signal lamps show which equipment is in operation, and a horn sounds if a feeder stops.

The straight-line diagrams show essential control connection. Assume that induced-draft fan No. 1 is to be started. If its damper is not already closed, the operator closes it my manipulating an air valve on the control board. When the damper closes, switch *SI* makes contact and red light Rd_1, lights to show the operator that the fan can be started. He then presses the start button and energizes relay coil No. 20. This relay closes its two contacts, one of which is in series with closing coil 5 on No. 1 induced-draft-fan motor switch. Switch 5 closes and starts the motor.

Contact 20′ forms a holding circuit around the start button and damper switch *SI*. Closing of this contact permits the start button and damper switch to open and the motor to continue in operation. When the damper on the fan is opened, negative pressure developed in the boiler uptake closes pressure switch *PS* in series with relay coil *PS′*. This relay closes its contacts PS_1 in series with relay coil ID_1. Energizing this relay closes contacts ID_1 in the forced-draft fan and coal-pulverizer motor-control circuits.

Switch *PS* has a time element and comprises a mercoid switch carried on a float in a liquid pool. A U-tube connects the liquid pool to the fan intake. When pressure is reduced in the induced-draft fan intake, liquid gradually flows from the reservoir down into the U-tube and switch *PS* closes. If for any reason a positive pressure is created in the fan intake such as if the

fan stopped, liquid flows back into the reservoir and opens switch *PS* to shut down the forced-draft fans, pulverizer and coal feeders. It requires considerable time for liquid to flow from or into the reservoir, so that switch *PS* is not affected by short sudden changes of pressure in the boiler uptake.

When damper switch *SI* is opened, red light Rd_1 goes dark but Rd_3 remains lighted to indicate the fan is running. A circuit for light Rd_3 is from the right-hand side of overload-relay contact *OL* to the right-hand side of light Rd_3, through the light to the right-hand control line.

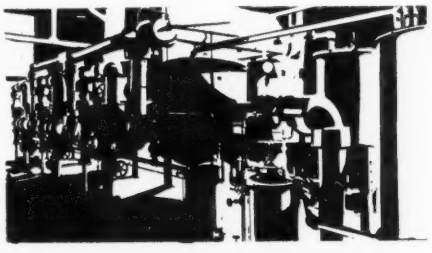
After relay ID_1 closes its contacts, either forced-draft fan or any coal-pulverizer motor may be started. This also applies to closing of switch ID_2 when No. 2 induced-draft fan is started. Before a forced-draft fan can be started, its damper switch *SF* must be closed by closing the damper. When this condition exists, red lamp Rf_1 or Rf_2 lights to show that the damper has closed and its fan can be started. Either forced-draft fan is started and its control functions in much the same way as that of the induced-draft fans.

Switch S_1 is a rotary type that may be closed to permit forced-draft fans to be started when an induced-draft fan is not running, but the fan damper must be closed so that the motor will be started under reduced load. Switch S_1 is closed by a detachable vertical handle inserted from the top of the control bench. To remove the handle, the operator must open the switch, and it is required that the switch handle be removed at all times except when used to close the switch. This insures against switch S_1 being closed and putting a forced-draft fan into service without an induced-draft fan running, except when the interlock protection is intentionally removed to operate a forced-draft fan when the boiler is out of service.

Starting Pulverizer Motors

Starting the pulverizer motors involves operations similar to those in starting the forced-draft fans, red running lights *RP* showing when the control circuits are alive. Switch S_1 has two poles, one of which is in the pulverizer-motor control circuits and allows any pulverizer to be started without an induced-draft fan running. Assume pulverizer No. 1 is started. When its control circuit is closed by closing start button and relay-contact 20, interlock-relay coil P_1 is energized. This relay closes contact P_1 in series with the control circuit for feeder No. 1.

The feeder-motor shunt-field winding is connected directly across the line and is energized all the time the line switch is closed. Feeder-motor speed control is by manual or automatic field-rheostat adjustment. Contact *F* is on the motor starter and is closed to short-circuit the shunt-field rheostat until the motor is accelerated to normal full-field speed.



When the start button is closed, it provides a circuit from + line through overload-relay contact *OL*, contactor coil 5, contact LO_1, the start and stop buttons, contact P_1, motor series-field winding and to — line. Contact 5 closes and 5*A* opens, the former connecting the motor to the line through the starting resistance, and the latter disconnecting the braking resistance. This action is followed by accelerating contacts 6 and 7 closing in turn to cut out the starting resistance, and finally *F* opens to put the field rheostat in series with the shunt-field winding.

The motor is now running at a speed determined by the field-rheostat setting. When contact 5 closed, LO_2 also made contact to provide a holding circuit for No. 5 contactor coil. When contact 7 closes LO_1 opens and puts resistance R_1 in series with contactor coil 5. Overload relay coil SC_1 is in series with the ammeter on the pulverizer motor. If coal is fed to the pulverizer too fast and it becomes overloaded, relay SC_1 closes its contact, completes a circuit for relay coil *S*, on the feeder-motor control, and closes contact *S* across the shunt-field rheostat. This brings the feeder down to slow speed to give the pulverizer a chance to clear itself. When the overload clears, relay SC_1 is released and the feeder motor is automatically put back on field-rheostat control.

Feeder Signal Relay

When the feeder motor was started by closing the start button, a circuit was also provided for signal-relay coil FR_1. Energizing this relay closes contact FR_1 in series with red lamp RP_1, contact FR_1 in series with relay coil H_1 and opens contact FR_1 in series with the horn circuit. Closing FR_1 contact lights red lamp RP_1 to show that the feeder motor is running. When relay FR_1 closes it energizes relay H_1 which pulls in contact H_1 to make its holding circuit. Relay H_1 also closes contact H_1 in the horn circuit, but the horn is not sounded because contact FR_1 is open.

If the feeder motor stops for any reason, contacts 5, 6 and 7 open and 5*A* closes. The latter connects the dynamic-braking resistance across the armature circuit. Relay coil *LO* is connected across the dynamic-braking resistance and is energized by it to hold contact LO_2 closed and LO_1 open until the motor practically comes to rest. When contact LO_2 opens, relay FR_1 drops out and opens contacts FR_1 in the red signal-light and H_1 relay circuits, but this relay remains closed through its holding contact H_1. Contact FR_1 closes and sounds the horn. When red light RP_1 goes dark it shows the operator which feeder is shut down. Pressing the horn-stop button opens the circuit through relay H_1 coil, its contact drops out and the horn stops sounding. The control for the other two feeders, not shown, is the same as that described for No. 1 and each is interlocked with its respective pulverizer.

Power is indebted to E. H. Barry, power supervisor, W. Va. Pulp & Paper Co., for assistance in the preparation of this article.

How would you test a new prime mover when no load is available? It takes real ingenuity. Here they

MOTORIZED A HYDRO UNIT

By A. J. F. Montabone

Consulting Engineer, Montreal, Que.

WHEN the new 136,000-hp. hydro-electric plant of James MacLaren Power Co., Masson, Quebec, was ready for testing in 1933, there was no suitable load for testing it. We found it almost impossible to use water rheostats with their costly temporary connections and accessories. Power lines were not complete to the plant, therefore outside load was not available. To provide the test load, we decided to reverse rotation of one unit, using its generator as a motor and waterwheel as a hydraulic brake.

This plant comprises four 34,000-hp. Canadian Allis-Chalmers vertical-shaft francis wheels, operating under 185-ft. effective head, directly connected to 28,000-kva. 0.85-p.f., 13,200-volt, 25 cycle, 3-phase, 166.7-r.p.m., Canadian Westinghouse generators, having directly connected main exciters and pilot exciters. Two machines were selected for the test, one to operate as a generator, the other as a motor. Changes were made in the lead connections of the latter, its top guide bearing was removed and its oil grooves changed, to permit reversal of shaft rotation. The gear pump on the top guide and Kingsbury bearings was also repiped.

Lubrication

The waterwheel guide bearing is normally lubricated by a viscosity pump mounted directly on the main shaft, there being a separate motor-driven pump as an auxiliary. The latter was used during the test as it required no change in rotation, while the viscosity pump would not supply oil if reversed. Waterwheel governors were put on hand control, except as noted below.

We thought that the Kingsbury thrust bearing on the motor unit might give trouble when reversed, but the designer advised that it would operate safely. We found it did this with approximately 2 to 5 deg. F. lower temperature than when running in the normal direction.

Since it was not possible to start the units with their own exciters in operation, temporary connections were made from another exciter, so that both units were excited from one source when starting. After the main oil switches and field switches of the respective units were closed, the driving unit governor was opened by the hand-wheel until both units were slightly above speed. They were then cut apart, the driving unit being excited from its own exciter, the motor unit from the separate exciter. The oil switches were closed again so that the generator supplied power to the motor.

The machines were now ready for load, the driving unit having been placed on governor control, but using the hand-wheel stop so that a given load could be carried. This stop was moved from time to time as the gates on the driven unit were opened to supply water for required braking effect, up to full load.

We found that 0.4-gate opening on the braking unit fully loaded the generator. Load could be maintained more constant than if a commercial load were used. Complete control over power factor, voltage, load and water was maintained without the least trouble and could be varied at will.

Vibration in the machine operating as a motor was slightly more than normal, but not excessive, and no trouble was experienced. This unit was also more noisy than normal, but not more than could be reasonably expected from the changed water conditions. Its balance was not affected. It took about 8 hr. to bring the generator up to constant temperature. The machine had been run under a short circuit for drying-out purposes before commencing the test.

After the test, the buckets of the runner used as a brake were found polished on both sides. Signs of pitting were evident on the concave side of three buckets. This is contrary to conditions usually found in normal operation. The polishing action of the water acted as a deep etching to bring out any slight defects in the castings. This and the pitting, however, were minor.

Generally Applicable

There is no doubt in my mind that this test can be made successfully on all size units, whether horizontal or vertical, without involving temporary equipment. The unit acting as a brake does not have to run long enough to do it any permanent injury. The method is comparatively simple, will provide load for the test and show up defects in wheel design or workmanship.

I believe that specifications covering generators and

waterwheels should contain a clause to the effect that the units "must be designed so that they may be run in reverse direction from normal, for test purposes." This will eliminate necessity of waiting months after equipment erection to make specified tests.

Temperature of the unit run as a motor was approximately 7 deg. higher than that of the generator, which was anticipated as its fans were designed to operate only in one direction. The top guide bearing can be made with oil grooves suitable for running in either direction. The lower guide bearing gets its oil from above and needs no alteration when made part of the design. Separate motor-driven oil pumps are required, but these should be part of any hydro unit.

Thanks are due T. F. Kenny of the James MacLaren Co. for the opportunity to conduct these tests, and to F. Nagler, chief engineer, Canadian Allis-Chalmers Co., who offered constructive advice and criticism. I am also indebted to the Canadian Westinghouse Co. officials and engineers for their generous co-operation. The tests were witnessed by Prof. C. V. Christie, McGill University, A. C. Bird, H. S. Ferguson & Co., consulting and designing engineers, New York, N. Y., R. E. Day, designing engineer, Canadian Westinghouse Co., and T. F. Kenny, The James MacLaren Co., Ltd., Buckingham, Que.

FAN FORECASTING

By H. R. Phelps
American Blower Corp.

HAVE you ever tried to determine the performance of a fan operating under conditions considerably different from those specified in performance curves furnished when the fan was purchased? This occurs frequently in induced-draft fan service where flue-gas temperatures vary considerably from those expected when the equipment was specified.

Fan performance follows certain laws which are the tools necessary to predict capacity, horsepower, speed or pressure for the new conditions from the original performance curves. These laws need only be applied correctly to give close results. They are:

A. When fan speed is changed,
   1. Capacity varies directly as the speed ratio.
   2. Pressure varies directly as the square of speed ratio.
   3. Horsepower varies as the cube of speed ratio.

B. When system resistance is changed,
   1. Capacity and speed vary as the square root of pressure.
   2. Horsepower varies as the $(\text{pressure})^{3/2}$

C. When temperature varies (constant volume and speed),
   1. Horsepower and pressure vary directly as the air density or inversely as the absolute temperature.

D. When temperature varies (constant weight of air),
   1. Capacity, speed and pressure vary inversely as the density or directly as the absolute temperature.
   2. Horsepower varies inversely as the square of the density or directly as the square of absolute temperature.

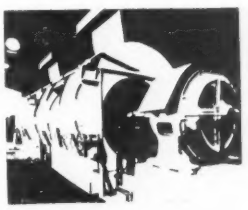
E. When temperature varies (constant pressure),
   1. Speed, capacity and horsepower vary inversely as the square root of the density or directly as the square root of the absolute temperature.

F. When both temperature and pressure vary,
   1. Capacity and speed vary as $\sqrt{\text{pressure} \times \text{absolute temp.}}$
   2. Horsepower varies as $\sqrt{\text{pressure}^3 \times \text{absolute temp.}}$

In the above laws, capacity is in cu.ft. per min., temperature in deg. F., pressure in in. water, density equals weight in lb. per cu.ft. and speed refers to r.p.m.

As an example, assume a fan serving a system passing 100,000 c.f.m. at 800 deg. at 6-in. static pressure at 690 r.p.m. requiring 135 b.hp. Suppose no change is made in fan speed or system and gas temperature drops to 360 deg. This situation is covered by fan law *C*. Density of 360-deg. air is 0.04848 lb. per cu.ft. and 800 deg. air is 0.03156 lb. per cu.ft. Then the density ratio is $\frac{0.04848}{0.03156}$ or 1.536. The fan still handles 100,000 c.f.m., but system resistance changes directly as the air density, or 1.536×6 in., $= 9.226$ in. the new static pressure. If this resistance is calculated by the absolute temperature it becomes $\frac{800 + 460}{360 + 460} \times 6$ in. to give the same result of 9.226 in. Fan horsepower changes in this same ratio, so 1.536×135 equals 207 b.hp. at this new condition.

The temperature ratio method is more convenient than the air-density ratio method because fewer calculations are involved. However, air density can be easily calculated by remembering that 70-deg. air has a density of 0.075 lb. per cu.ft. and density varies inversely as absolute temperature; then 800 deg. air will have a density of $\frac{0.075 \times (70 + 460)}{(800 + 460)}$ which equals 0.03156 lb. per cu. ft. This value of 0.075 lb. per cu.ft. is based on a barometric pressure of 29.98 in. of mercury and must be corrected to agree with the pressure of the particular locality.



BOILS WATER AT 22,000 VOLTS

Change in 18,000-kw. electric steam boiler raises efficiency 50%, permits successful operation on highest voltages ever used

By Francis A. Westbrook
Consulting Engineer, Center Conway, N. H.

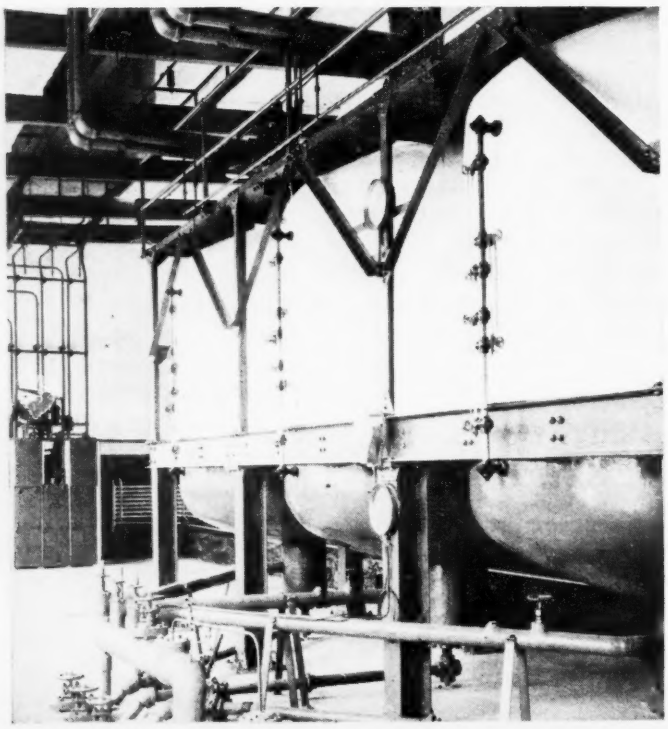
ONCE upon a time, the 18,000-kw. electric steam boiler at the Brown Company, Berlin, N. H., eked out 40% efficiency in generating steam from surplus hydropower on Sundays and holidays and during high-water or light-load periods. But now its efficiency is 90%. Here's why:

The boiler has three tanks, one per phase, operating at 125 lb. gage pressure, and with a combined rating of 18,000 kw., or about 54,000 lb. of steam per hr. For a 6,000-kw. load and less, it is operated on 11,000-volt power and for greater loads 22,000 volts, transmission system voltage.

To obtain efficient performance at these voltages, two problems had to be solved. One had to do with electrodes, the other with concentration of salts in the boiler due to evaporation and resulting power unbalance between the three boiler tanks. These were solved after careful tests and experiments by Mr. Robertson, engineer in charge.

Cylindrical electrodes used for 6,600-volt boilers were not suitable, because a larger area of immersion was needed than they provided. Too-violent boiling of the water caused vibration. It was very much like what happens when a blacksmith immerses a red-hot steel bar in water. To overcome this, electrodes composed of many rods set in a ring were tried. Finally, 66 rods set within a 14-in. circle (this being the largest that would go through the manhole) were arranged in three concentric circles and staggered so that boiler water can flow to them freely.

18,000-kw. electric steam boiler at Brown Co., Berlin, N. H., that operates at either 11,000 or 22,000 volts



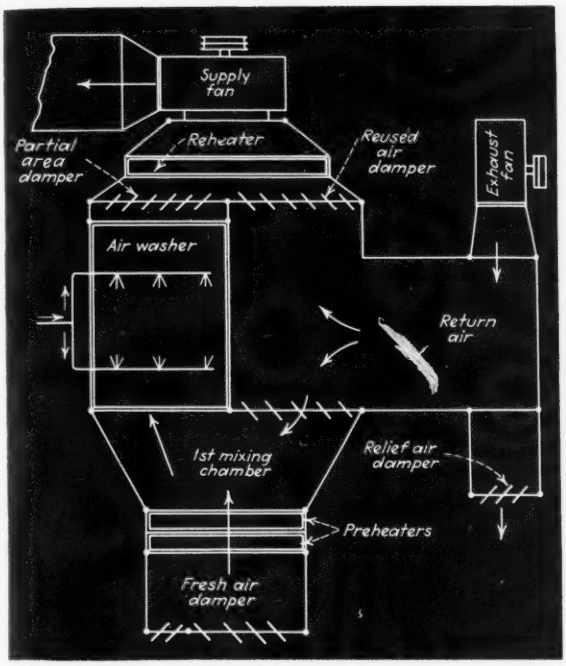
To balance the load on the three phases requires equal water resistance in each of the three tanks. Due to concentration of water impurities as evaporation takes place, there is a decided tendency to unbalance power taken by each tank. To maintain the necessary uniformity of water resistance, water is constantly bled from each boiler and the blowdown passed through a heat exchanger for heating feedwater.

Concentrated impurities have a tendency to float at or near the water surface. It is therefore not sufficient to bleed from the boiler bottom. This is also inefficient. Fresh feedwater comes in at that point, and part of it will be drawn off immediately with the blowdown. A surface blowdown was therefore arranged. This consists of 1.5-in. pipe, perforated with $\frac{1}{8}$-in. holes 5 in. apart, set in two semi-circles attached to the ground sheet of the boiler and placed in a plane 3 in. below the electrodes. Surface blowdown is then led to the bottom header by six $\frac{3}{8}$-in. pipes.

This change greatly improved boiler performance, but something more was still to be desired. They tried delivering feedwater directly to the electrodes. This meant a non-conducting pipe capable of standing heat and submersion. Pyrex glass tubing did the job very well. A 2-in. tube brought up through the center of each boiler and 2 in. inside its electrode gave the desired results. In this way, fresh feedwater is brought immediately in contact with the multiple-electrode unit. Boiling of the water forces the impurities toward the boiler shell, and as they rise to the surface they are drawn off through the blowdown. This change raised efficiency to an average of 90%, although there are times when it is somewhat higher.

Importance

Importance of electric boilers as a means of utilizing excess hydro power is shown by the power consumptions for 1933 by the Brown Company boiler, which amounted to 59,323,900 kw.-hr. And remember that the boiler is in service only when there is a surplus of water power otherwise wasted. During low production, the boiler is used more than at times of manufacturing-plant peak operations. Of course it is used on Sundays and holidays when operation is suspended, or at other off-peak periods when there is an excess of water available.



A typical "bypass" set-up

per min. per person is supplied, objectionable odor is likely to result.

In summer when refrigeration is used, the temperature of air leaving the washer is such that the saturated air carries with it only enough moisture to produce a relative humidity of 40 to 55% when at room temperature. If the room is at a temperature of, say, 78 deg., then with no moisture gain in the room, supply air would be cooled to 53 deg. in the washer to produce a relative humidity of 40%. But saturated air supplied to a room at this temperature may cause considerable discomfort because of drafts.

There are several ways to overcome this. Air may be reheated by tempering stacks as it leaves the air washer. This obviously requires steam and seems to be wasteful. It is more economical to reheat or temper the air by mixing it with return air that has not passed through the air washer. When this system is employed, usually up to about 50% of the return air goes through the air washer and the remainder is mixed with conditioned air after the washer. Dampers in the bypass duct offer means of controlling the air volume bypassed. For example, if return air is at 78 deg. and 40% relative humidity and the fresh air

WHERE THE AIR WASHER?

By R. B. Purdy
Associate Editor

LAST Month, "Air Washers Provide Moisture to Order" described performance characteristics of the air washer as used in air conditioning. Let us now see how this equipment fits into a central system. It doesn't have to be in a building basement. It can in fact be placed wherever space is available, but remember that ducts carry conditioned air from washer to conditioned space and fresh air and return air back to it. Thus, the nearer the air washer to the space to be conditioned the shorter these duct runs, consequently the lower the first cost.

A fan is usually connected to the washer discharge and delivers the air to the supply duct system. The inlet end of the washer connects to a plenum chamber into which is drawn the fresh air supply and air returned by exhaust fans from the conditioned space.

Unless objectionable odors are encountered, as in air conditioning restaurants or kitchens, returned air may be reconditioned and circulated back to the conditioned space. This saves refrigeration in summer and heat in winter. In fact the greatest economy would be obtained if no fresh air were brought in at all. But this can't be done; recirculated air alone soon becomes stale and smelly. About 25% of the air supplied is fresh air, although this varies with weather and character of the space conditioned. Experiment shows that if less than about 10 cu.ft. of fresh air and 50% of the return air is cooled to 53 deg., then upon mixing with the unconditioned return air the temperature of the supply will be 63 deg. dry-bulb, 56.8 deg. wet-bulb and a relative humidity of 70%. In this example, we assume that no moisture will be absorbed by the air in the conditioned space. In practice, this is practically never the case, and the moisture gain must be allowed for. Occupants of a room, for example, add 700 to 900 gr. of moisture per hour per person, depending on temperature.

Another method of tempering supply air that has been used recently is to discharge the air nearly vertically through nozzles at rather high velocity. As the air issues from the nozzle an injector action takes place which entrains room air with the supply air, causing the two to mix thoroughly, quickly raising the temperature of the supply to avoid objectionable draft. These nozzles are often placed under each window and all return air is recirculated through the air washer.

Since with this system temperature difference between entering air and room air is greater, the volume of air supplied is somewhat less. To avoid drafts, supply air should not be over 10 to 20 deg. below room temperature.

Extended surface-heating elements are shown in the plan placed in the fresh air duct and in the duct just before the inlet to the supply fan. Elements in the fresh-air duct must be capable of heating the air above 32 deg. for all outside temperatures, to remove likelihood of freezing water in the air washer. Heating elements at the fan inlet must be installed, even though not needed for summer tempering as they are required for winter heating.

HOW TO BUILD

By Burton W. Wheeler

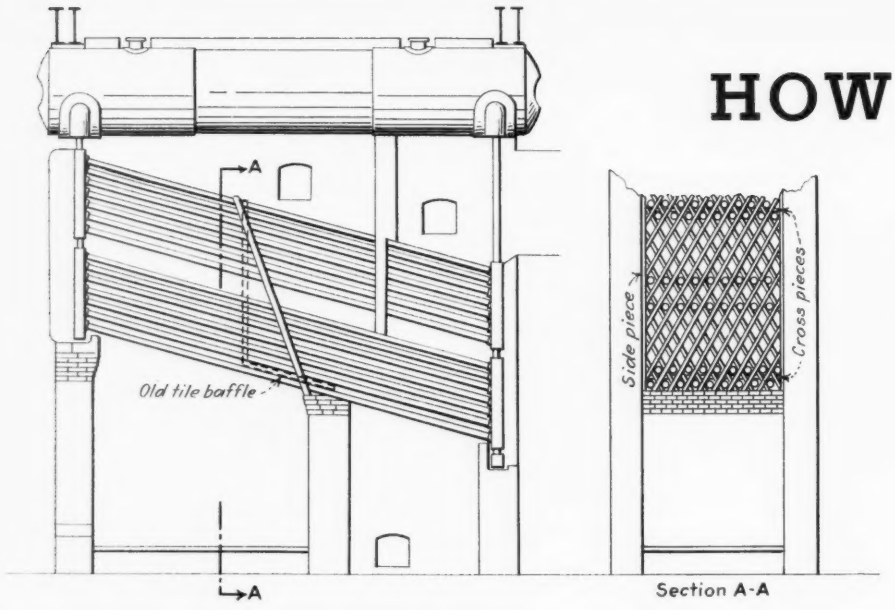


Fig. 1—Location of new baffle and form used to position it

RECENTLY we renewed the first baffle in some of our longitudinal type B. & W. boilers and at the same time changed baffle location. These boilers were oil fired, and we'd had a lot of trouble with burning out of the horizontal section of tile baffle and consequent short-circuiting of the gas and lowered efficiency. Dusting doors were so located that when tubes were blown with a hand lance, soot would pile up in back of the vertical baffle. By placing the new baffle as shown in Fig. 1, this trouble was eliminated and at the same time we exposed more tube area to the radiant heat of the furnace.

Old tiles were removed by knocking them out with long bars. We found that the easiest way to remove the flame plates, which were bolted together, was to use a long bar, *J*—Fig. 2, with a slot forged in the end large enough to straddle the ends of the plates. By rotating the bar, we could twist the plates off. The broken plates would then drop down between the tubes into the furnace.

Since the new baffle was rammed into placed instead of being poured, only a form for the back of the baffle was necessary. The first pieces of this form to be put in were the top and bottom crossboards. They were about $\frac{7}{8}$ in. thick, 4 in. wide, and long enough to extend from side wall to side wall of the furnace. They were positioned as shown in Fig. 1, between the two top and two bottom rows of tubes. Since these pieces determined the location of the baffle, they had to be installed firmly and correctly. They were held in place by wooden wedges driven between the tubes and the boards.

Next, the two side strips were put in beside the furnace walls. These strips extended from the top to the bottom crosspieces and fit in notches cut in the ends of the crosspieces so that all edges come flush. These pieces prevented the lattice of the form from going askew at the side walls and were held in place by wooden wedges. The lattice was then put into place, being lined up by the side and cross pieces. The first rows of the lattice were $\frac{3}{4}$ x $\frac{7}{8}$ in. thick, and the ends were nailed to the crosspieces. The second rows of the lattice were 5/16 x $\frac{3}{4}$ in. and were nailed to the first rows, thus tieing them all together.

Before putting in the forms for the baffles, all the necessary furnace repairs were made. In our case it was necessary to corbel out the top of the bridge wall to bring the bottom of the baffle forward enough to clear the dusting doors.

The plastic of which the baffle was made consisted of a mixture of 800 lb. of high-temperature cement and 625 lb. of crushed firebrick. Good results were obtained in mixing by placing a layer of crushed firebrick on a cement floor and then a layer of high-temperature cement and then a layer of crushed brick and having the workmen shovel the material over and over, adding only enough water to give the consistency of putty. While stored before use, it should be kept covered with wet burlap bags to prevent the moisture from evaporating. When ready-mixed plastic is used, about 13 lb. per tube is required.

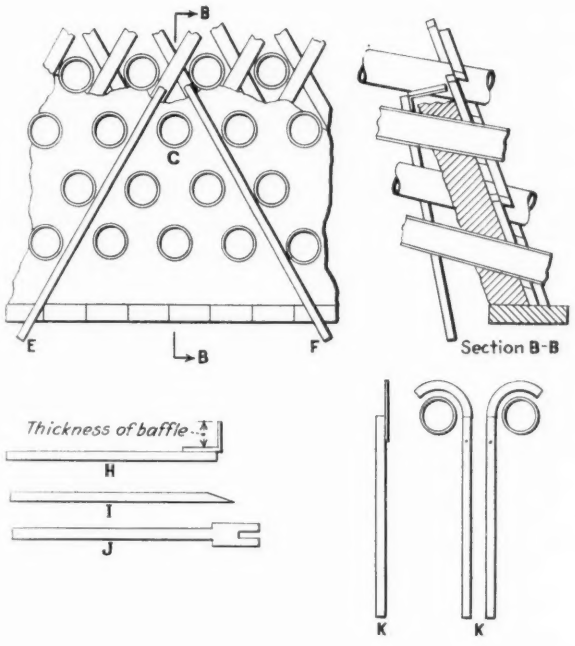
Tools needed to fill the baffle are few and of simple construction. Ours consisted of three or four wooden sticks approximately $\frac{3}{4}$ in. square and of varying lengths. One has a thin piece of steel bent at right angles and nailed to the end of a stick as shown at *H*, Fig. 2. The ends of the sticks without the steel angle should be bevelled to an angle of 30 deg., *I*—Fig. 2. Two are tipped with curved-steel ends, *K*—Fig. 2. When it is necessary to work from the top row of tubes, as in a double-deck boiler, a small wooden block is used instead of the steel angle and a shallow tin chute is used to drop the plastic down between the tubes to the top of the baffle.

At the start in filling the baffle, the plastic is placed around the bottom rows of tubes by hand as far up as the workman can reach. Plastic is then made into balls about the size of an orange and stuck onto the bevelled end of a stick by which it is shoved into place. After a few balls have been placed on the baffle, the steel angle, *H*, Fig. 2, is called into play. Using

A MONOLITHIC BAFFLE

Relocating and replacing tile with plastic high-temperature cement solved a burn-out problem and raised furnace efficiency

Fig. 2—Section of baffle, showing how plastic is placed on top of tube *C* and special tools used



it as a hoe, the plastic is pulled down around the tube and brought to the right thickness. By working in different tube lanes to reach the same point on the baffle, as at *E* and *F*, Fig. 2, it is possible to work the material all around the tubes. The curved end tools, *K*, Fig. 2, are used to pack the plastic around tube tops.

In a double-deck boiler, it will be necessary to put in the upper half of the baffle by working from the top of the tubes in the first pass. The baffle between the tube banks of our boilers was built up by a small workman who crawled in between the banks and placed the material in position with his hands. To keep the wet plastic from falling down, because at this place it has little support, three layers of unbonded firebrick were placed against the face of the baffle. After a few hours the plastic set enough to remove the bricks.

This type of baffle can be put in by ordinary workmen under a mason foreman. Only enough water should be added when mixing the plastic to give it the consistency of putty, for too much water will cause the baffle to sag and ruin it. Extra care should be used in pulling the material down with the hook to fill in around the tubes. If this part is carelessly done, there will be holes in the baffle that will not show up until after the boiler is fired.

Anecdotes of Two Old Engines

By Charles A. Green

Cleveland, Ohio

DURING a visit to the Century of Progress Exposition, while looking over the old engines, I was reminded that during the World's Fair of 1893 the triple-expansion Corliss engine shown by E. P. Allis Co., developing, I believe, 3,500 hp., was claimed to be the most powerful stationary engine in use.

At that time, however, and for about four years previously, there were in use two engines developing in daily service 5,000 hp. One, a triple-expansion Corliss built by Hicks & Hargreaves of Manchester, England, was running under full 5,000-hp. load in a light and power station in London. The other engine, a pair of twins with 40 x 48-in. cylinders runnining condensing, was in the "Baaces" wire rod mill in Cleveland, Ohio, developing 5,000 hp. The latter engine is still running in the same mill, now known as the Consolidated Works of American Steel & Wire Co. This engine was built by Kilby Mfg. Co., Cleveland, after designs by a mechanical engineer named J. Neuert. I ran it during 1902 and 1903.

The Kilby engine had several peculiarities. Instead of the cranks being placed 90 deg. apart as in usual twin and cross-compound practice, they were 120 deg. apart. Why, I was never able to discover. The valve gear was driven by a train of spur gears from the main shaft, and when unhooked for movement of the valves by hand, it was possible (and sometimes happened) that one side was hooked up to go ahead, and the other side to back up, to the great discomfort of the operator.

About 1901 the steam chest of one side of the engine blew out, fortunately without loss of life or serious injury to the engineer, James Householder. The Kilby cylinders were then removed and the engine converted to a twin-tandem compound Corliss, with the cranks at 90 deg.

The main shaft and wheels of this engine weigh 175 tons.

WHITHER DIESEL BEARINGS?

By J. W. Anderson
Consulting Diesel Engineer

THE trend of diesel development has been towards smaller and lighter-weight engines for a given horsepower output. This means higher speeds and smaller over-all dimensions. In crankpin bearings the developments have brought:

1. Higher speeds due to higher r.p.m.
2. Shorter actual bearings due to smaller over-all engine dimensions (particularly in automotive types).
3. Smaller ratios of bearing length to diameter, due to shorter actual bearing lengths (as listed under 2), and larger shaft diameters to avoid critical speeds.
4. Higher total bearing loads due to increased maximum combustion pressures, especially in small engines.

All in all, crankpin bearings have suffered.

It has been the custom to judge bearing sizes on the basis of maximum pressure, and the product of mean pressure and velocity.

In order to bring out the situation more clearly, two bearing lengths representative of the limits of the usual proportions are used, that is one crank bearing of nominal length equal to the diameter, the other with nominal length equal to half the diameter.

Take the crankpin diameter at $0.7D$ where D represents cylinder diameter. Take maximum cylinder gas pressure at 750 lb. per sq.in. Then nominal maximum bearing pressures for the two bearings are:

$$750 \times \frac{\pi D^2}{4} \div (0.7D)^2 = 1{,}200 \text{ lb. per sq.in.}$$

$$\text{and } 750 \times \frac{\pi D^2}{4} \div (0.7D \times 0.35D) = 2{,}400$$

But look at actual bearing pressures. Make a deduction in length for the fillets on the crankpin. Take the radius of this fillet as 5% of the shaft diameter. Then $0.05 \times 0.7D = 0.035D$.

Second, an oil groove feeds oil up the connecting rod to the wristpin bearing. Take the width of this as 0.05 of shaft diameter, or $0.035D$.

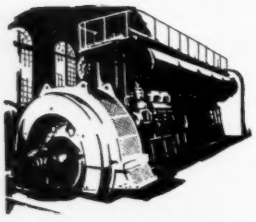
Third, there are usually wide side clearance pockets which take off say 30 deg. on each side of the diameter. Thus, the angular extent of the actual bearing is about 120 deg. and the projected length of this is $0.866 \times 0.7D = 0.606D$.

Then actual projected areas of the bearings are
$0.595D \times 0.606D = 0.361$, say $0.36D$,
and $0.245D \times 0.606D = 0.149$, say $0.15D$.

And average projected pressures on the bearings for each 100 lb. per sq.in. in the cylinder (neglecting inertia) are:

$$100 \times \frac{\pi D^2}{4} \div 0.36D^2 = 218 \text{ lb. per sq.in.}$$

$$\text{and } \frac{100 \times \pi D^2}{4 \times 0.15D^2} = 525 \text{ lb./sq.in.}$$



This must be balanced by oil film pressure. This varies from zero at bearing edges and oil groove edges (relatively speaking an oil supply pressure of even 75 lb. in the oil groove is negligible compared with the oil film pressures) to a maximum in the vicinity of the bearing areas. The recent A.S.M.E. paper on bearings indicates that the maximum film pressure is about 5/3 of the mean. Furthermore, the projected area of the bearings is rectangular, and while the curves of uniform oil film pressure will follow the general shape of the bearing area, the corners will be rounded. Hence a coefficient, which will be taken at 0.9, must be used in order to approximate the true maximum oil film pressure.

$$\text{Then } 218 \times \frac{5}{3} \div 0.9 = 403 \text{ lb. per sq.in.}$$

$$\text{and } 525 \times \frac{5}{3} \div 0.9 = 970 \text{ lb. per sq.in.}$$

In other words the actual maximum lubricating oil film pressure is about four times in one case and ten times in the other case, the cylinder gas pressure.

Taking the inertia factor at 250 lb. per sq.in. of cylinder area, the maximum film pressures approach 2,000 and 5,000 lb. per sq.in. respectively for the two bearings discussed.

But there are many contributory conditions which must be considered. It is well known that the oil film in a bearing is established by wiping the oil into the bearing circumferentially as the journal or shaft revolves. Oil film pressure causes the oil constantly to tend to leak out of the bearing sideways. Side leakage in a short bearing is several times that in a long bearing due not only to the differences in pressure but also to the shorter distances the oil must travel to escape.

In other words, instead of having bearings which have nominal length to diameter ratios of 1.0 and 0.5, the actual ratios are more nearly 0.5 and 0.25. The oil film just cannot maintain itself (too much side leakage) even when bearing pressures are low.

Another important phase is the rapidity of increase in pressure. As the crank passes top dead center, gas pressure in the cylinder sweeps upward in a smooth but rapidly rising line from the compression pressure curve into ignition and combustion, to the maximum combustion pressure. There is an increase of 400 to 450 lb. per sq.in. in about 20 to 25 deg. of crank angle. This means an *increase* in the maximum oil film pressure of about 1,700 lb. and 4,300 lb. in the bearings under discussion in 1/640 sec. at 2,400 r.p.m., or 1/80 sec. at 300 r.p.m. Thus there is an intense hydraulic hammering on the bearing metal.

As pressure rises in the oil film, the resistance to shearing of the oil film increases and there is intense local heating. This tends to reduce the viscosity of the

oil, which tends to break down the oil film, which tends to increase the coefficient of friction if the breakdown proceeds to the region of boundary lubrication. It is another of those vicious downward spirals, and the net effect is always to create intense local heating which tends to damage the bearing metal.

The whole point is that recent diesel design trends have brought about a very undesirable, if not to say serious, crankpin bearing situation. Under the circumstances, it is not at all surprising that there have been difficulties due to cracking of the white metal in the bearings. So far, the difficulties have been met by turning to lead bronze bearings, but in any case it would seem desirable to improve bearing conditions.

There are other ways of getting oil up the connecting rod to the wristpin without cutting the crankpin bearing in two with an oil groove. So the bearing conditions will be examined with this groove omitted. The oil hole or holes in the crankpin should also be moved around so that they will not be opposite any part of the bearing surface, in the vicinity of top crank center. Thus the crankpin bearing surface will be unbroken and the only opportunity for the oil to escape will be at the bearing sides. This is the condition which frequently prevails in main bearings.

Actual projected areas of the bearings will then be:
$0.63D \times 0.606D = 0.382$, say $0.38D^2$
$0.28D \times 0.606D = 0.170D^2$

And the average projected pressures on the bearings for each 100 lb. of cylinder pressure will be:

$$\frac{100 \times \pi D^2}{4 \times 0.38D^2} = 206 \text{ lb. per sq.in}$$

$$\frac{100 \times \pi D^2}{4 \times 0.17D^2} = 460 \text{ lb. per sq.in.}$$

Using the same factors as before maximum film pressures become 380 and 850 lb., which are not greatly below those for the bearings with oil grooves, but advantages gained are very definite. Pressures are lower. There are only two leakage boundaries instead of four. Distances the oil must travel in order to escape are much greater. Probably the total leakage is not more than $\frac{1}{3}$ or $\frac{1}{4}$ of what it is in the other bearings. This means a better oil film with oil-film pressure better distributed over the bearing area. The bearing is thus ever so much better able to withstand the severe loads placed upon it.

With the oil groove omitted, the duty on the short bearing is only a little over twice—not $2\frac{1}{2}$ times—as severe as on the long bearing.

Natural Gas Drives Steam Turbines

By F. L. Kallam

Industrial Engineers, Inc.
Los Angeles, Calif.

MANUFACTURE of gasoline from natural gas presents an opportunity for appreciable reduction in power costs. This is particularly true where gas processed is at relatively high pressure, 400 lb. for example, and a portion of the gas, free of gasoline fractions, is needed at low pressure for boiler fuel to generate process steam. It is possible to obtain the required fuel at the necessary low pressure by using a turbine as a reducing valve. Power developed by the turbine is then available for driving manufacturing pumps.

At the plant of Los Nietos Producing & Refining Co., Kettleman Hills, Calif., this has been carried out. When treating 100,000,000 std. cu. ft. of wet gas per day at a pressure of 450 lb., 47,875 lb. of steam an hour are required for pumping and process purposes. This is furnished from five 1,500-sq.ft. H.R.T. boilers with water walls and superheaters. Steam is available at the turbine throttles at 145 lb. pressure and 125 deg. of superheat. When water, stabilizer and shipping pumps are operated on gas, steam required for plant operation is reduced to 38,375-lb. per hr., approximately a 20% reduction.

When the manufacturers were approached regarding use of gas motive power for conventional steam turbines, they advised that it would be necessary to use 300-lb. gas in place of 150-lb. steam, and to double the number of nozzles and reversing chambers. This was done in one water-pump unit, but gas pressure was not raised above 185 lb. By actual trial, however, we found that the extra nozzling was unnecessary.

After several months of continuous use, turbines operated on gas were opened and the runners inspected. No signs of erosion or corrosion were found. We decided however, to preheat the gas to about 200 deg. in a steam preheater to insure against a possible "freeze-up" at the exhaust port.

Operation of these conventional steam turbines on gas has been very successful. Test data from one unit is given in the table.

Test of Steam Turbine Used with Gas[1]

Test Number	1	2	3
Turbine r.p.m.	2,925	3,150	3,350
Gas pressure past governor, lb. per sq.in.	64	70	77
Gas pressure at turbine exhaust, lb. per sq.in.	12	12	12
Temperature gas to turbine, deg. F.	194	197	200
Temperature gas from turbine, deg. F.	100	105	110
Gas to turbine, cu.ft. per 24 hr. at 60 deg. and 14.7 lb. per sq.in. abs.	965,000	1,072,000	1,178,000
Pressure on pump suction, in. Hg.	0.7	0.5	0.3
Pressure on pump discharge, lb. per sq.in.	52	57	65
Temperature of water, deg. F.	72	75	75
Water pumped, g.p.m. (meter)	582	620	666
Water pumped, g.p.m. (pump curve)	540	610	645
Pump efficiency, per cent (pump curve)	76	75	75
Brake hp. at pump coupling	21.6	27	32.7
$\frac{n-1}{n}$	0.144	0.130	0.119
n	1.161	1.15	1.136
Theoretical hp. of gas	55.8	64.3	75.4
Efficiency of turbine, percent	38.7	41.8	43.4
Specific gravity of gas at 4-oz. and 60 deg. F. (air = 1)	0.62	0.62	0.62
Analysis of gas (all tests) percent by volume			
Methane		85.61	
Ethane		9.14	
Propane		4.00	
Butanes		1.25	
Pentanes and heavier		0.00	
		100.00	

[1] This is one of the turbines not renozzled for gas. It has a rated steam capacity of 95 hp. at 3,000 r.p.m. but could not be run at full capacity because of the size of the pump it drives.

MORE ABOUT PIPING

By Bernard Kramer

Pittsburgh, Pa.

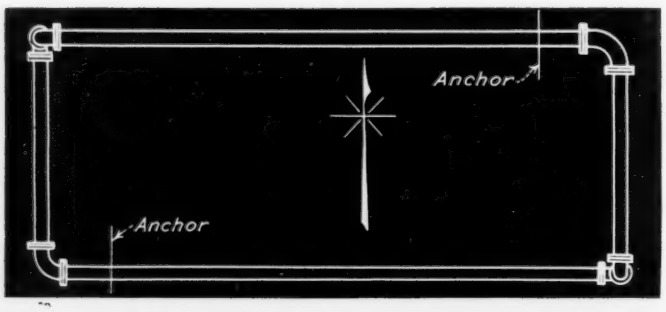
I SHOULD like to comment briefly on some of the points mentioned in the February data on piping (pages 81-93). On the recommended velocities in pipe lines you give for exhaust lines—6,000 to 15,000 ft. per min. This seems to be a wide enough range to cover practically all conditions, except that in condensing, high-vacuum steam exhaust lines velocities up to 30,000 ft. per min. are permissible. Again on service water lines including pump suction and drain lines the lower limit of 300 ft. per min. is hardly low enough. 120 or 150 ft. per min. would be more in conformity with approved practice. The upper limit of 600 ft. per min. on the other hand seems a somewhat too high velocity.

In general, other things being equal, higher velocities may be allowed in larger diameter pipes where the ratio of friction surface to the area of fluid passage ($2\pi R/ \pi R^2$) becomes lower. In a 2-in. pipe, for instance, the above ratio is 2. For a 20-in. pipe, the same ratio is 2/10 or 0.2. In other words, there is ten times less friction surface per unit of area in a 20-in. pipe than in a 2-in. pipe.

When expansion loops or bends are used, the pipeline should be cut short so that its length will be right at a temperature halfway between the maximum and minimum. If, for instance, the line may be subject to zero temperature (during a shut-down) and 400 deg., the pipe should be cut to the length it would have theoretically at 200 deg.

Loop Headers

Expansion loops and U-bends may sometimes be avoided, and the same results obtained by a less cumbersome change in direction. In designing a steam pipe loop (not an expansion loop) for an oblong-shaped room so as to allow for repairs to any section of the loop without a major shut-down, I have often used the scheme of placing one side and one end of the loop, say the north and east, on a horizontal plane above that of the south and west. The two planes are joined by offset bends at the northwest and southeast corners and the loop anchored at two points near the northeast and southwest corners as illustrated. Such a design looks quite neat and logical, especially when there is a gallery along one or two sides of the room.



Talking about expansion bends reminds me of a story, something that really happened in my experience about 25 years ago. I was working for a pipe-contracting concern specializing in making pipe bends. The pipes were filled with fine sand, then heated and bent on a bending table in the usual way. To keep the inside of the bend from buckling, a hose was played along the inside of the bend during fabrication. This naturally stretched the bend and consequently thinned the metal along the outside. In bending pipe to a shorter than standard radius, extra-strong pipe was used for making bends to compensate for this thinning of the outer skin. In the bending of large-sized pipes, this procedure was inadvisable, so the process was reversed. During bending, a hose was played along the outside to prevent it from stretching too much. This naturally caused the inside of the bend to buckle. The pipe-bending shop foreman was telling me once how inquisitive the customer's inspectors are sometimes and how he manages to get around them. "He asks me," says the foreman, "what these buckles are there for." (This pointing to the corrugations inside a 30-in. pipe bend). "I says to him, these are put there to take care of expansion." I wonder if that foreman lived to see corrugated bends made intentionally to improve flexibility of plain pipe bends.

Drainage

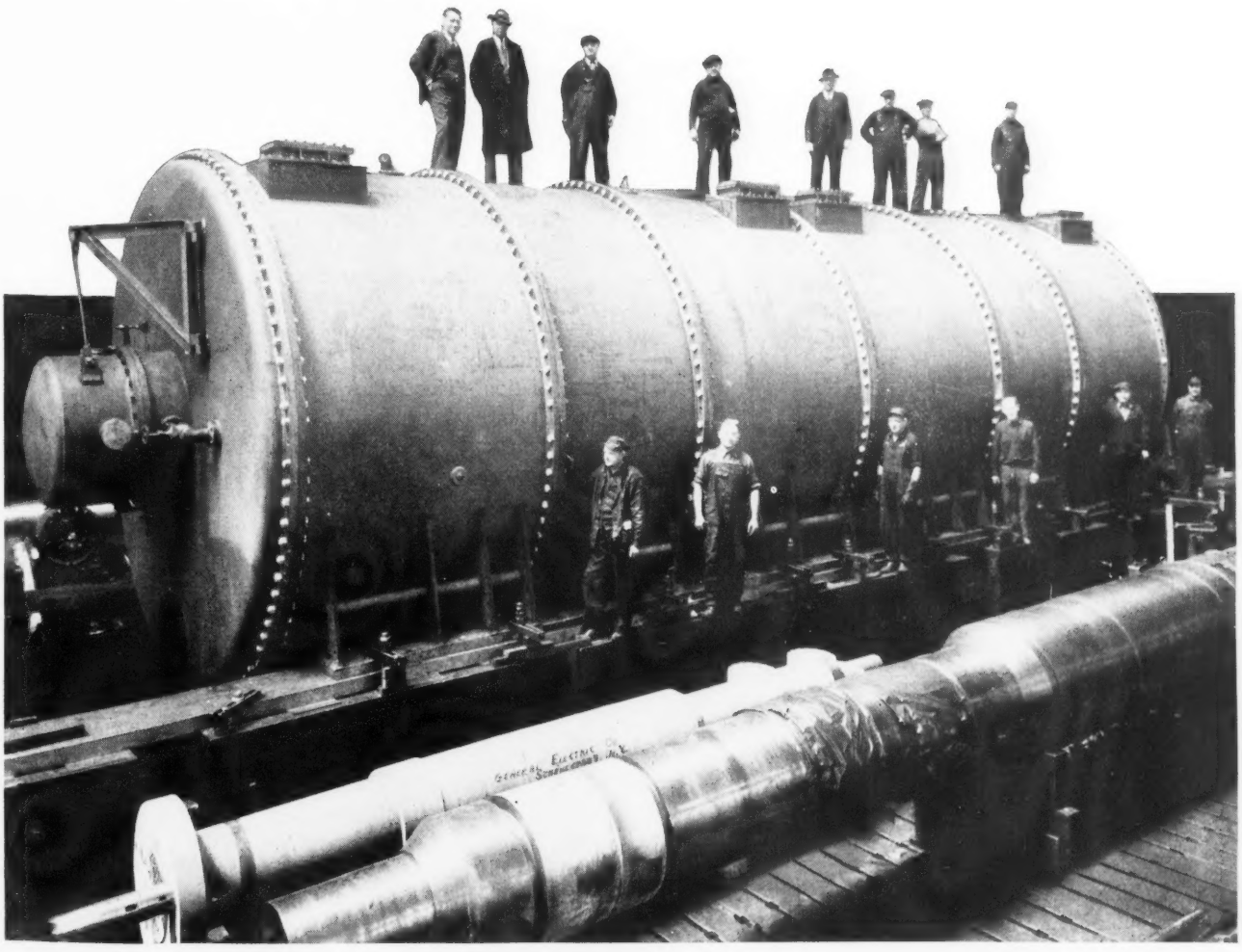
The importance of draining vertical steam risers above the valve cannot be emphasized too strongly. Some valve manufacturers make their gate valves with bosses to either side of the disk so that they can be tapped for a drain connection at any time.

It is good practice to place a self-cleaning strainer in addition to a good steam separator before any important steam-driven unit. The strainer is simply a fitting with a fine screen inclined at an angle of about 45 deg. deflecting downwards any solids that may have passed the separator. A valve at the bottom of the strainer permits the accumulated solids to be blown out periodically.

Among the useful tools for pipe installation and maintenance work, I would add a simple pipe-bending tool. It is simply a crowbar with a rounded end. The bar is inserted into the straight pipe on the bending table and pulled, kinking the pipe slightly. By repeatedly pulling out the bar a little and giving the pipe to be bent a second kink, a third, and so-on, bends to any degree and to almost any radius can be shaped. I have seen a device like this used to bend 2-in. seamless boiler tubes cold, forming a U-bend having a 3-in. radius at the centerline. The bends came out perfect and without visible deformation.

NEVER BEFORE

FIRST frequency changer in which are incorporated the advantages of operation in a hydrogen atmosphere is this unit for the Freemansburg, Pa., substation of Pennsylvania Power & Light Corp. Hydrogen is a more efficient cooling agent than air and much less dense, meaning reduced size and 90% reduction in windage losses. An outgrowth of G.E. development work on hydrogen-cooled synchronous condensers, this unit will convert 60-cycle to 25-cycle power. Its 24-pole, 12,000-volt, 300-r.p.m. motor is rated at 23,500 kva. at 0.9 p.f. The 22,222-kva. generator is a 10-pole, 6,900-volt unit operating at 0.9 p.f.



A day on the poles

BACK of BEYOND

By N. L. Rea

Supt. of Elec. Installation, General Electric Company

IT IS hard to appreciate in this day and age how primitive living and working conditions are in some parts of our world, and also how a man can surmount difficulties when necessity says "Must."

Some years ago an erector was detailed to handle an electrical installation for a gold mine "Back of Beyond." The order specified that as far as possible, the boxes must be under a certain size to go in dugout canoes, and less than a given weight for packing. Large pieces could be handled, but with great difficulty and expense. Delivery had to be made before a certain date, as a tropical river must be navigated (or one might say "climbed") late in the rainy season when floods were subsiding.

Beef on the Hoof

The canoe trip was fairly easy—only about four weeks of paddling, poling, tracking and portaging, over rocks and through jungles to the landing place. The cases were then packed on oxen to go to the mine. The work, climate and insect pests soon got the best of any pack animal, so oxen were used because there was a food value to be salvaged. For obvious reasons old mule or horse didn't rate with beef.

The larger pieces were carried in a "pit pan" made by splitting a large dugout lengthwise, separating the halves and filling the gap with planks. Of course, everything got more or less wet, as was to be expected. A box of armature coils might be half full of water when opened. A transformer core plus a bark rope made a fair anchor to hold a canoe at the foot of a rapid, "and in the name of Heaven why should the crazy foreigner get mad and scold about a simple thing like that? Is it not hard work to hold a canoe with a pole? And a man must rest!"

After weeks of heart-breaking work the equipment arrived at the mine. Assembly and erection were started. The mine owner had purchased waterwheels, generators, power-station and transmission-line equipment. However, he had overlooked altogether the necessity of insulators, wire and cable for connections inside the power house. To order and wait for this material meant a year's delay. There was lots of transmission wire and a good supply of insulating tape and varnish, so the power house was wired with annealed transmission wire insulated by hand and supported on hard-wood blocks, these blocks being baked and boiled in oil.

Temporary drying ovens were made and all equipment baked thoroughly while the air was kept in circulation. This removed all possible moisture before the plant was started. Help was, of course, poor and scarce, so most of the work had to be done by the erector. After weeks of work, talk and worry, the equipment was ready to go. Careful short-circuit drying was done. All of the equipment put into service with only two failures—the armature of the synchronizer burned out, and the transformer that had been an anchor failed from mechanical injury.

Round Wire—Square Hole

Lamps were rigged for synchronizing, and transformer repair started. Examination showed that about 100 ft. of the secondary conductor must be replaced. This was square wire with the corners beveled slightly. The transmission surplus was again called on, a length of hard-drawn wire annealed, and the native blacksmith and helper set to work to hammer and file the copper until it would go through the hole of a gage made from a bit of scrap iron.

Tension by Indian

A wooden mandrel to fit the transformer coil was provided with handspikes for turning, and mounted in wooden trunnions. The coil was mounted in this "lathe," Fig. 1. First the ends of the old and new conductors were scarfed for about 2 in., as in Fig. 2, then spotted together, tinned, riveted and sweated. The new conductor was carefully taped while the Indians on the handspikes kept the tension, or slowly wound the conductor on the coil.

After this repair was completed, the synchronizer armature was tackled. The insulation was charred but the fine wire was not broken, so the armature was put to soak in a jar of "alky." Every day a little wire could be unwound as the shellac and varnish softened. At the end of a few weeks the wire was all off.

Rewinding was the next problem. An old silk dress and shellac were available. One layer of the cleaned bare wire was wound over a strip of silk, taking care that the turns were separated. Then the spaces between them were filled with several coats of shellac to bind the turns in place and serve as insulation. A second strip of silk and layer of wire was applied—and so on to the end. Reported the erector: "Of course it took a few minutes every day for weeks but I had an armature at the end. If I had ordered a replacing one, delivery was several months off, provided some Indian didn't lose it, or just let it lay at some portage or camping place."

It speaks mighty well for the equipment, plus the erecting engineer, that the plant went in service with so little trouble and gave good service.

Chief No-Shoot

The trip down river took fewer days than it did weeks to go in. For canoe ballast they brought out several boxes of raw gold. This "rated" a guard in the shape of an old, trustworthy native whose badge of authority was an ancient 45-90 Springfield rifle. That this rifle lacked a hammer and ammunition caused no worry. Doubtless, other members of the party felt safer from injury or death, and shipments always went through safely.

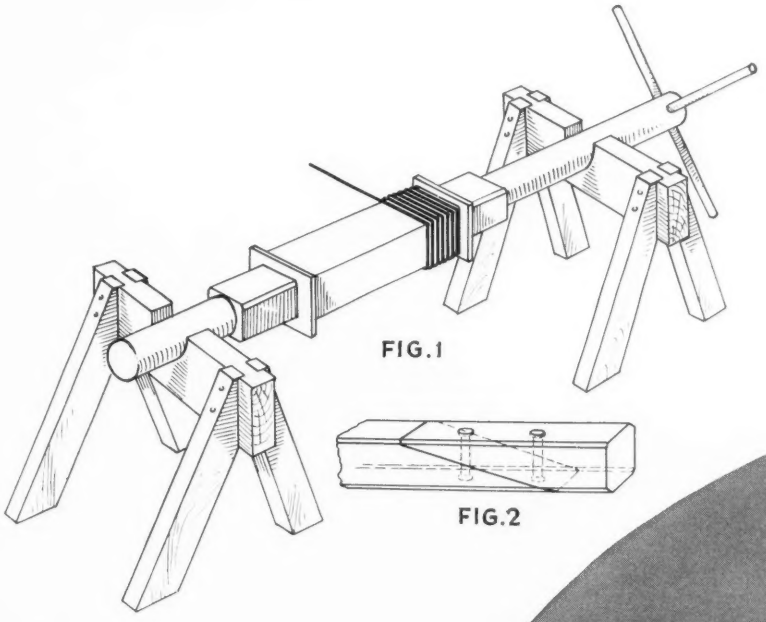
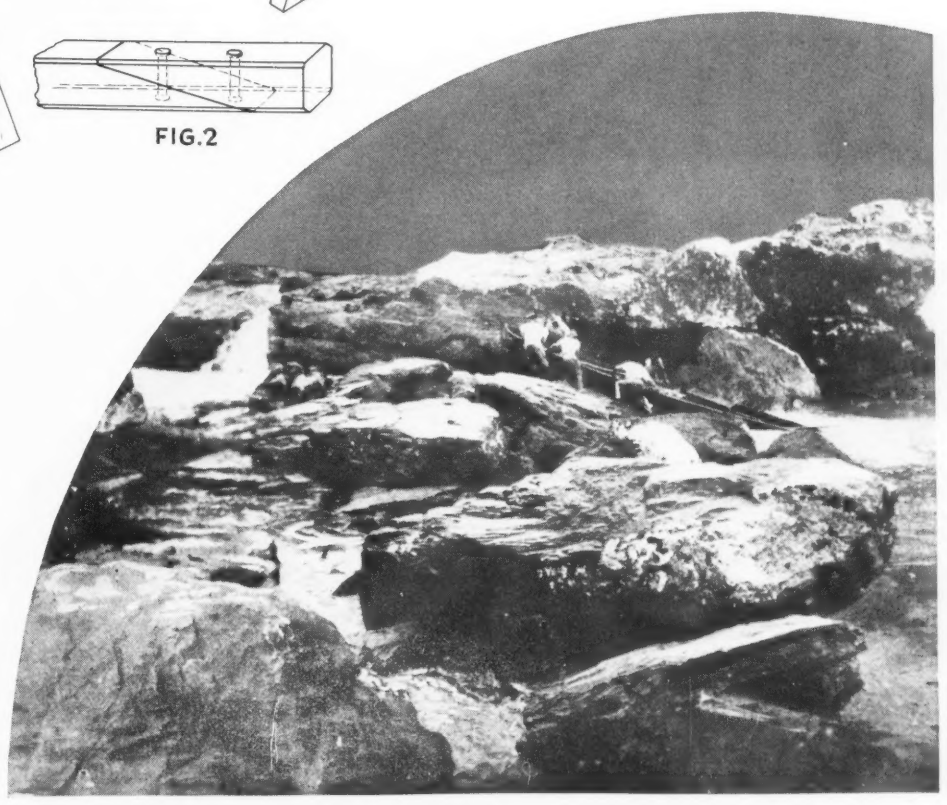


FIG.1

FIG.2

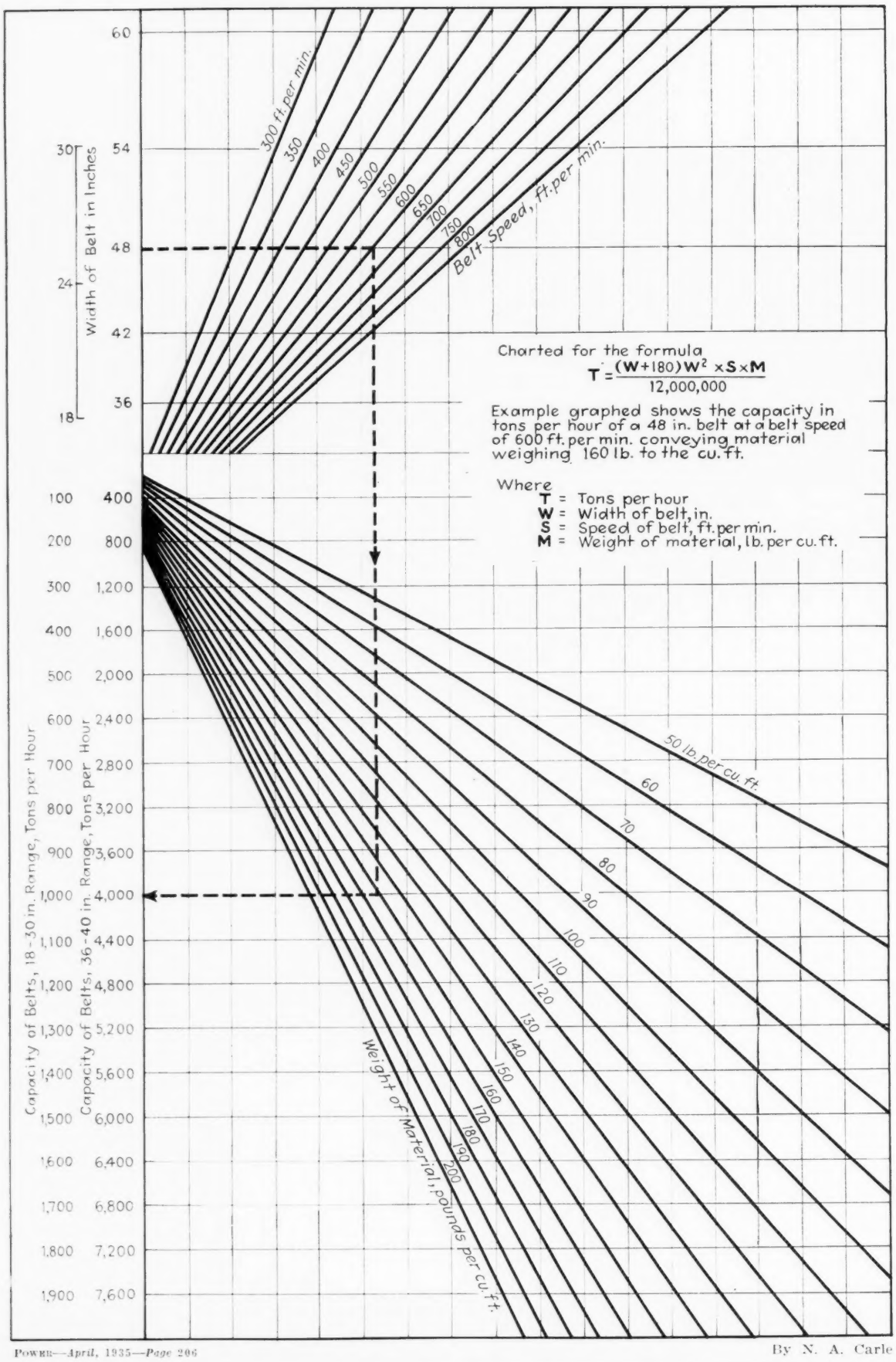
Indians on the turnspikes, a wooden mandrel on horses and square wire formed from round — that's what a transformer core is remade of



Sometimes the dugouts carried the men, but sometimes . . .

Number 31

Capacity of Conveyor Belting



By N. A. Carle

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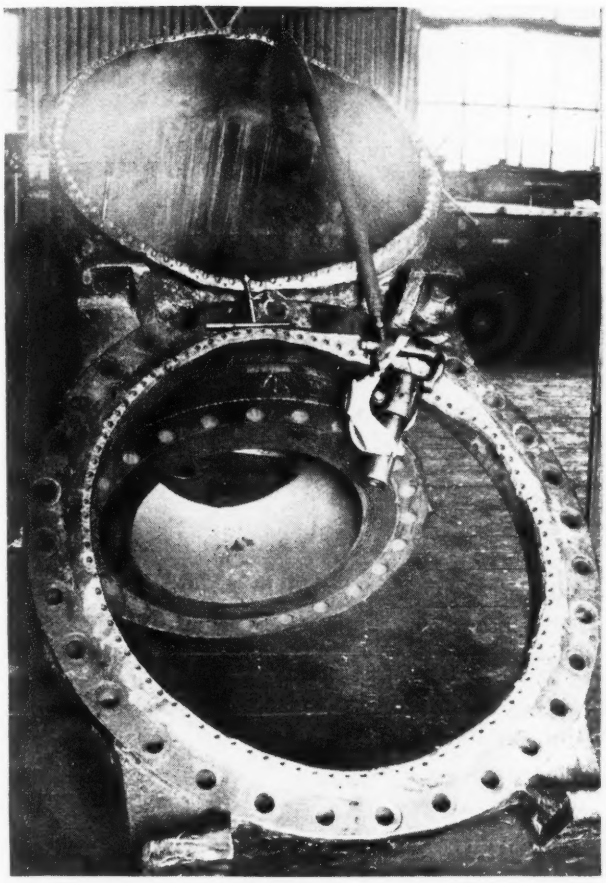
PRACTICAL AIDS TO OPERATION



Electroplating Closes Pores in Cast-Iron Weld

THE photograph shows how part of a large heat-exchanger body casting was repaired. This part is a 30- x 30- x 20-in. cast-iron tee which, when in service, is exposed to hydrocarbon gases under 500 deg. F. temperature and 60 lb. per sq.in. pressure. During a temporary shutdown in severe winter weather, water accumulated and froze in the lower end of the heat-exchanger body, thus causing the bottom flange to break off. Three weeks would have been required to obtain a new casting.

Ordinarily this would be a simple oxy-acetylene welding job with either bronze or cast-iron welding rods. Corrosive gases might attract the weld, however, and eventually cause failure; or the weld might not be as strong as the parent metal: the casting might warp and require refacing (and we had no shop facilities available to handle a casting of this size). Electric welding was therefore decided upon because preheating was not required.

The flange was first drilled for $\frac{3}{8}$-in. bolts on 1-in. centers, then it was placed on the body and the same drill used for centering preparatory to drilling. The flange was then removed and the casting drilled and tapped for $\frac{3}{8}$-in. patch bolts. Metal on either side of the patch-bolt circle was chipped away to expose the bolts and at the same time provide a vee for welding. A few $\frac{1}{4}$-in. holes were then drilled and tapped alongside and in between the $\frac{3}{8}$-in. holes for studding which is generally required to facilitate electric welding. After the bolt holes on the flange face were countersunk for the patch bolts, the flange was applied, bolts screwed down tight and heads chipped off flush with the flange face. Bolt size was calculated to give required strength in tension to take care of operating pressure.

Welding was done in the usual manner, but shortly after the work was started, sand holes and other small casting defects were encountered which prevented a good weld. After welding was completed, a hydrostatic test revealed hundreds of tiny leaks through and adjacent to the weld metal. Caulking the leaks proved futile, therefore electroplating the weld on the inside of the casting was attempted, using a welding generator to supply the current. We were not worried about joint strength, as it was believed that the patch bolts had sufficient strength for that.

Before the weld was electroplated, it was thoroughly sandblasted and cleaned with a caustic solution. A head was applied and the casting set in a vertical position with the flange downward. A 0.5 x 2 x 29-in. O.D. welded-steel ring was made and throughly sandblasted on its circumference. This ring was suspended in the casting concentrically with the inner surface of the weld. The electrolyte was composed of 1 lb. ferrous chloride ($FeCl_2$) and $\frac{1}{8}$ lb. of calcium chloride ($CaCl_2$) for each gallon, the remainder being distilled water. Electrolyte was kept hot during the plating by a small steam coil. The steel ring was connected to the positive side of the generator and the casting connected to negative through a band comprising several turns of copper wire wound around the outside of the casting at the weld.

Plating continued for 16 hr. A current density of 1 amp. per sq.in. of effective ring area was used at the start. This proved to be high and was reduced to about 0.25 amp. After plating, we had to caulk one or two small spongy areas. The finished job was tested under 85 lb. pressure and no leaks could be detected. The casting has been in continuous service for a sufficient time to prove the job entirely satisfactory, and nearly three weeks operating time was saved.

Edwardsville, Ill. L. H. KENDALL

Poor Foundation Caused Generator to Vibrate

AFTER a 3-bearing d.c. generator had been down for repairs it would not build up. Its pulley face was wide enough to take two belts, one going in one direction to an engine shaft, the other directly opposite to a waterwheel shaft. Excessive vibration due to a poor foundation was found responsible for the trouble.

Concrete had crumbled under the pulley end-rail nearest the waterwheel side of the machine. Assuming that the rails were originally level, we jacked up that corner of the bedplate and shimmed between it and the rail to bring the bedplate level. To equalize the air gap and line up the three bearings, we balanced tension of the opposing belts. We perched a workman on top of the belt with the least tension and had him hitch along toward the middle of the drive. Bearing pillow blocks were loosened and gradually the arma-

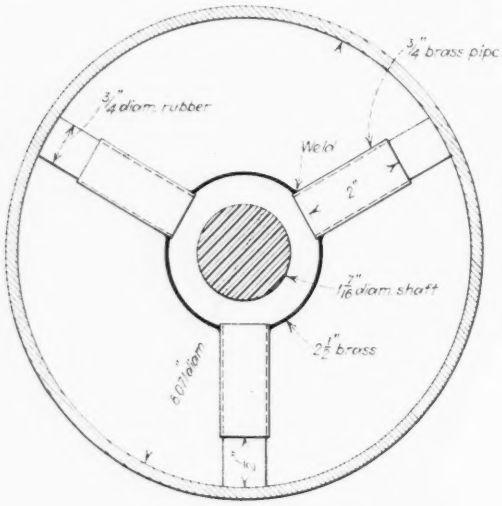
ture was pulled over to the center horizontally. Jack bolts on the commutator end and outboard pillow blocks were used to center it vertically. The middle bearing pillow block was allowed to follow the shaft and, when the outer bearings were bolted in position, its jack bolts were tightened until we could feel the bearing begin to take some weight. It was then bolted in place and our human balancing weight advised to get off the belt, as we were ready for a trial. The machine ran smoothly and commutation was perfect.

It should be understood that this was emergency work, and the master mechanic was advised to put a new foundation under the machine as soon as possible. The point to remember is that the foundation under a machine should support the weight equally at all points.

Montague City, Mass. MAX PAFENBACH

Electrolytic Action Stopped in a Deep-Well Pump

PUMPING salt or brackish water from a deep-well sometimes causes electrolytic action between dissimilar metals in the pump assembly. Using Toncan iron pipe for the casing and



insulating the pump-shaft bearing support stopped such action in one case.

Four months after installing a 600-g.p.m. deep-well pump, a considerable falling off in capacity was noted. The water, which was decidedly brackish, was used over ammonia condensers. A spare 240-g.p.m. pump was put in service and the larger pump pulled from the well. The ordinary 8-in. steel pipe originally used as a casing was found badly corroded. The pump impeller also was eaten away, giving evidence of electrolytic action. Toncan iron pipe replaced the steel-pipe casing and the pump again put in service. After about eight months of service, pump capacity again began to decrease. Examination revealed electrolytic action still taking place, although at a slower rate than formerly.

The second time, in addition to replacing several sections of the iron-pipe casing which was badly pitted, the shaft-bearing supports were changed, as in the figure. Three $\frac{3}{4}$-in. brass pipes were brazed to the $2\frac{1}{2}$-in. brass pipe forming the bearing supports and $\frac{3}{4}$-in. diameter rubber inserted in the $\frac{3}{4}$-in. pipe to provide a solid support and insulate the bearing and shaft from the casing. After the pump had been in service for over three years, operating steadily for about seven months each year an examination showed no signs of electrolytic action or corrosion.

Incidentally the smaller pump, a duplicate in material of the larger one as first installed, although pumping the same kind of water gave no corrosion trouble.

New York, N. Y. EUSTACE C. SOARES

Tagging Safety Valves

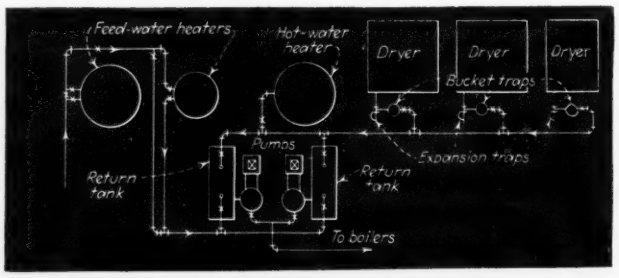
A SYSTEM for identifying safety and relief valves in a large industrial plant was recently worked out. This company had installed a considerable number of safety valves on its boilers, air tanks, compressors, process lines. Heavy gage 2- x 3-in. brass tags were procured, one for each safety valve. On these tags were stamped three numbers: the number assigned to the particular safety valve to which the tag was to be attached, the pressure setting of the valve. (This pressure being determined by trial), and the maximum allowable working pressure of the unit protected by the valve. Each tag was firmly wired to its assigned valve.

A notebook containing these three numbers for each valve, the safety valve location, and the date at which the valve was set at the noted pressure was filled out and kept by the chief engineer. Before this system went into effect no one person remembered more than part of these important figures. It is now only necessary to glance at the safety-valve tag and test its popping pressure to learn how much leeway there is for possible pressure increase, or if the safety valve setting has been tampered with. It is well for a responsible person to check this periodically.

Philadelphia, Pa. B. R. BROWN

Expansion Traps Cure Feed-Pump Troubles

IN A textile-mill power plant, returns from several process dryers, a water-heating system and other equipment were lead into two closed tanks and discharged from them directly to the boilers by two duplex pumps. Make-up water passed through a tempering heater where its temperature was raised to about 100 deg. F. and through another heater (using ex-



haust from auxiliaries) that increased its temperature to 210 deg. F. From the second feedwater heater, makeup went into two return tanks. High-pressure and low-pressure returns coming into these tanks at times raised the temperature to 250 deg. F. so that water going to the feed pumps was well above boiling temperature at atmosphere.

Everything worked satisfactorily as long as all equipment was in service. When a dryer was taken out of service, however, and allowed to cool to permit removal of stock, trouble began. The feed pumps sometimes would become noisy and

vibrate violently when returning a dryer to service. This trouble was found to be caused by a flood of cold returns from the dryer coming into the return tanks and creating a vacuum.

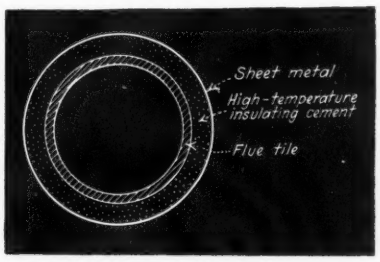
After a couple of months of experimenting to eliminate the trouble, an expansion trap was installed between each dryer and its bucket trap, as in the figure. When a dryer cools off now, its expansion trap opens to the sewer. Then when it returns to service, as long as its returns are below a certain temperature they are discharged to waste. When the return temperature increases to a safe value, the expansion trap closes and the bucket trap discharges them to the return tanks.

New York, N. Y. C. W. PETERS

Insulated Stack to Prevent Corrosion

WE HAD experienced considerable trouble with steel stacks rusting out on a small incinerator at our Buffalo, N. Y., plant. Our local engineer, A. M. Creenan, then had the present stack installed. It has been in operation for over two years without any signs of the old trouble.

As indicated in the drawing, this stack consists of a flue-tile



inner shell surrounded by high-temperature insulating cement, in turn supported and protected by a sheet-metal case. All of the joints between the flue-tile sections are made with high-temperature cement which prevents condensation working into the insulation and destroying its properties. The insulation prevents heat loss through the stack and permits most of the moisture to be discharged into the atmosphere.

Buffalo, N. Y. H. A. CREGO
Chief Engineer
Grennan Bakeries, Inc.

Corrects Power Factor and Cuts Power Costs

ABOUT a year ago, I received an assignment from a cold-storage and ice-plant manager to study and make suggestions how to reduce his purchased-power costs. A large part of the power is purchased at 220 volts, 3-phase, 60 cycles, and the balance obtained from a 150-kva. hydro-electric plant. Suitable log sheets were not used, so one of the first moves was to provide these and get them used. Tests showed a considerable loss of power due to defective insulation on power equipment and circuits. This condition I corrected.

Power factor was low. While the power company did not penalize in its rates for this, I found that the utility was willing to reduce the demand charge for any improvement in power factor above 0.85. To install capacitors or change from induction to synchronous motors would have been expensive, so I decided to correct power factor with the waterwheel generator.

Because the waterwheel had no governor and because of the size of the motors comprising the load, the generator could not be properly loaded. Generator polepieces had been drilled for a squirrel-cage winding. This winding was installed and necessary equipment provided to synchronize the machine with the utility line.

The generator is now synchronized with the power company's line, then loaded and the field coils over-excited so that purchased power is taken at practically unity power factor. Voltage at the distribution center is now 10 to 15 volts higher than it formerly was. Motors quite a distance from this switchboard had been giving trouble due to overload and low voltage. The increase in voltage has eliminated this trouble.

There are times when the generator is run as a synchronous condenser for power factor correction only. By opening the gates sufficiently to allow the waterwheels to overcome the machine losses, it compares favorably with capacitors. Operation of the plant is rather uncertain because of low head, high water, low water and anchor ice. But with all these handicaps, a saving of about $2,000 will be made on power bills for the first year. This will more than cover the cost of the changeover and interest on the money.

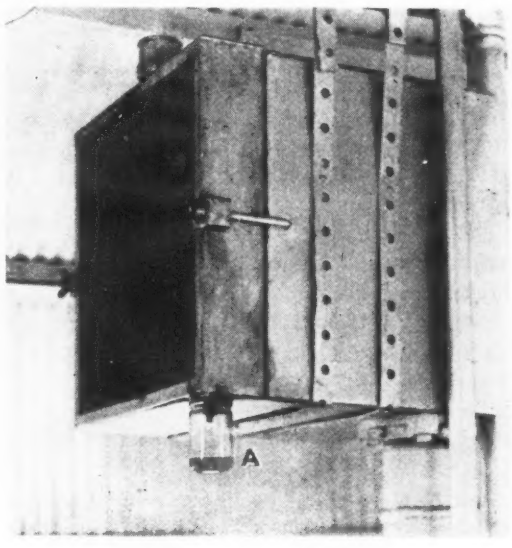
Binghamton, N. Y. WALTER J. RIDER

Prevents Oil Leaks From Air Cleaner

AIR cleaners, oil moistened by flow from a feed cup above them, purified the intake air on a battery of internal-combustion engines. The air cleaners operated satisfactorily, but excess oil from them dripped onto the engine and floor. One enterprising oiler finally secured a pint salad-dressing jar and a petcock from an old gas engine. He cut a hole in the jar screw top, sweated the cock into it, then inserted the petcock into the lower corner of the cleaner-unit case.

The jar was screwed into the lid as at *A* in the figure, and the excess oil from the filter drained into it. When the jar was nearly full, it took but a moment to empty it into the feeder cup, cutting off possible leakage with the petcock. The improvement aided in keeping the station clean and reduced the oil consumption per air cleaner to less than half that previously required.

Longview, Tex. ELTON STERRETT

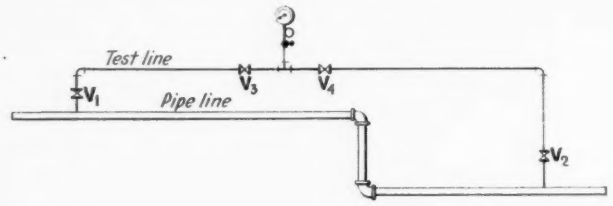


CURRENT COMMENT

Pressure Drop in Pipe Line Used to Estimate Flow

HAVING had considerable experience in measuring pressure drop across superheaters, I was interested in the article, "Pressure Drop in Pipe Lines Used to Estimate Flow," (*Page 38, January* POWER). I found in my work that using two gages to measure pressure drop was unsatisfactory even when the gages were reversed, as suggested by Mr. Phelps. The gages were checked with a dead-weight tester before starting the work, but still satisfactory results could not be obtained.

Using one gage with a syphon between the petcock and gage, as in the diagram, worked successfully. When pressure readings are to be taken valves V_1, V_2, V_3 and V_4 should be



opened to let steam circulate and clear the pipe of air. Then open the petcock slowly and let the syphon below the gage fill with water and cool so that the gage will be protected against steam temperature. With valves V_1 and V_2 open and V_3 and V_4 closed, open V_3 and note the pressure. Then close valve V_3 and open V_4, the difference in pressure will be the drop in the line between the two points where readings are taken.

There may be some question as to the accuracy of this method of measuring steam flow. Assuming that it is accurate to within $\pm$ 10%, the reading at least gives some idea of the steam flow, which is preferred to a wild guess. To make the reading a gage not less than 8 in. in diameter should be used, with the pound graduations divided in 5 or 10 parts.

Bogota, N. J. E. C. GRIEF

Release the Brake When Gaging Hoist Motor

R. M. STEVENS' article, "Make Sure of Induction Motor Bearing," in the February *Power*, brings to mind an experience in our plant. We have several hoist motors with the brake drums mounted on the motor shafts. Since there is always a possibility of a brake slipping and allowing a heavy load to run away, these brakes are carefully maintained.

When the electrical inspector made an inspection on one of these motors, he thought he smelled hot insulation. His initial checkup failed to show the source of the odor: the bearings were cool and the air gap gaged 0.020 in. on the bottom and 0.025 in. at the top and sides of the rotor. Although the motor had been shut down only a few minutes after an all-day run, stator and rotor windings were not unusually warm. When he looked through the air gap with a light, however, he thought he could see indications of rubbing between rotor and stator. He then blocked the brake shoes off the drum, after which a 0.005-in. gage could not be put in the air gap at the bottom. When the motor stopped, the brake held the rotor in a central position, thus keeping the shaft up off the bottom of the bearing. When the motor was taken apart, we found that the bearing on the brake end was worn 0.021 in.

Air gaps of these motors are gaged once a month by the regular-shift motor tender. He was fooled by the action of the brake, his reports showing that the air gap had gaged the same for several months. A thorough inspection is made semi-annually by a man especially trained for the work, and it was this inspector who found the trouble. The motor was not damaged, except that a few slot sticks were charred, but we might have lost a motor winding in spite of rigid inspection. We now make it a practice to release the brake when gaging the air gap of a motor that has a brake mounted on the motor shaft.

Rockland, Me. J. M. POMEROY

Boiler Tube Replaced in Two Sections

ON PAGE 683, *December*, 1934, POWER, there is an item by H. M. Spring, which in my opinion, is not practical. I have replaced boiler tubes under most conditions during the past 25 years, and never heard of such a suggestion. Such a thread on an extra-heavy fire tube would require to be tapered both internally and externally if no washer was used. In a boiler tube under operating conditions there is a certain amount of expansion and contraction. Lineally, such a joint under operation will not remain pressure-tight and it will not be nearly as reliable as an ordinary thick tube.

Mr. Spring suggests blanking off the holes. Personally, I think it would be safer. I know that boiler inspectors of this province would not allow such a joint to be used, and I think that there are many boiler inspectors in the United States who would not pass it, even of an extra-heavy tube.

I could name many defects which could and probably do exist in such a joint, made under ordinary conditions, but I will leave this for the consideration of practical steam-boiler repair men.

Toronto, Ont. JAMES E. NOBLE

What About Condenser Tube Scale?

I WOULD like to add a few comments to the answers published in the January number of *Power*, to November Question No. 2 concerning condenser tube scale.

We have experienced only moderate deposits in our surface condensers, but were troubled with heavy slime and sludge on condenser-tube surfaces, causing poor vacuum because of temperature-insulating properties of these formations. The installation is single-pass. Circulating water is taken from the river, shunted through the condenser and discharged into the river at a lower point. Variation in water temperature is small. Analysis of the water showed it composed of various

chlorides, carbonates and sulphates, such as sodium chloride, calcium carbonate and sulphate, and magnesium chloride and sulphate in various concentrations. Chemical reactions are dependent upon temperature and the concentration of the various constituents, bases and salts.

Screens are used to keep out the usual river debris. It was found that the sludge and slime consisted of minute particles of shell, coke, seaweed, sand and bacteria. This foreign material caked on the tubes and assisted the chemical reactions by entrapping the various chemicals.

To combat the slight scale formation and heavy sludging an electrolytic system was installed. A motor-generator set was placed close to the condenser (the closer it is the lower are the I^2R losses because high current at low voltage is required).

Graphite anodes are used in the water box and approximately 40 amp. per sq.ft. of condenser surface at 6 volts is passed between the anodes and the condenser-tube cathode. This current value may be increased or decreased depending upon water conditions and condenser tube arrangement.

Immediately following the installation, sludging ceased and vacuum on the turbine improved. Apparently, the electrolytic system liberated chlorine gas which deposited at the cathode and retarded adhesion of foreign material.

I would suggest that N.A.M. have his condenser cooling water analyzed and also note its condition with respect to foreign material, then give the installation of an electrolytic system serious thought.

No. Bergen, N. J. KERMIT G. HOFFMAN

Why Brushes Stick in Holders

ALL electrical machines fitted with brushes carry the risk of sparking and commutator trouble, especially when operating under severe conditions. Dirt is the most frequent cause of brushes stuck in their holders. The brushes and the insides of their holders should be cleaned at frequent intervals, and after cleaning, surfaces should be dusted with graphite powder. This acts as a lubricant to give free up and down movement of the brushes. It will help to prevent sticking and to keep out other dust.

Another cause of brush sticking is heat expansion. The brush may stick when hot but be free when tested cold. Hard-carbon expands very little unless heated unduly, but metal-graphite brushes expand considerably with only a moderate temperature rise. Therefore, if metal-graphite brushes are used with the same clearance as hard-carbon brushes, sticking is likely to occur if they heat. When brushes are tested for sticking, it should be done just as the machine is shut down before the brushes can cool off.

Bromley, England W. E. WARNER

Something for Nothing By Supercharging Diesels?

IN THE January number of *Power* is an interesting letter by Paul R. Sidler with reference to superchargers for diesel engines. I am interested in the statement that the energy for driving the blower is obtained at no cost. Mr. Sidler then states that caloric energy that is otherwise lost with the exhaust will be utilized. This looks to me very much like getting something for nothing, which is sometimes very difficult to do. The principle of operation of the turbine is not stated, but would seem to involve the use of either kinetic or pressure energy in the exhaust gases. It is hard to see how the heat content of these gases can be made to produce power in the turbine shown. The only way in which the heat itself could be used would seem to be in connection with a steam boiler to supply steam for the turbo-blower. If this is not done it would seem that the addition of the turbine to the exhaust line of the engine would seem certain to raise the back pressure and thus appreciably reduce the output of the engine.

I would be interested to see some discussion of this point, as there seems to be some breaking of the law of conservation of energy in the assumptions made.

In this same connection, it is often claimed that by making the intake pipe on an internal combustion engine of the right length, a ramming effect can be obtained which will actually increase the volumetric efficiency of the cylinder. This again seems like getting something for nothing and might well come in for comment in such a discussion.

Clemson College, S. C. B. E. FERNOW
Prof. of Mech. Engrg.
Clemson Agric. College

Make Electrical Controls Tinker Proof

PERHAPS one of the most prolific causes of crippled electrical controls of various kinds is the man with a flair for tinkering. Machine operators and others who have had no training or experience in the care of machinery are very often those who are most likely to attempt adjustment of controls with which they have to do. Not only is the time they spend in this manner lost, but the equipment with which they tinker is usually more or less abused.

When making installations which are especially liable to abuse, it is possible to forestall the tinkering bug entirely by placing the control equipment in an inclosure where it is not available except to those who have keys to the room. This places the responsibility directly upon one man. For new plants, it may even be desirable to place all control equipment in one room. The longer life and better service given by the equipment will usually offset the extra cost involved in making an installation of this nature.

Peoria, Ill. JOHN E. HYLER

Thrust Bearings Loaded to Destruction

IN YOUR Mid-December review of discussions of the December American Society of Mechanical Engineers papers on bearings, as copied by the American Society of Naval Engineers February *Journal,* there appears an error that should not pass unchallenged.

I believe my statement in oral discussion was that in our tests to destruction three babbitt-faced shoes with a total area of about 8 sq.in. carried 16,000 lb. before failure, whereas the highest load on solid phosphor-bronze shoes before failure was about 14,000 lb. The average pressure on the babbitted shoes was therefore about 2,000 lb. per sq.in. when failure occurred. The speed was 11,000 r.p.m. Moderate-speed bearings have tested to 10,000 lb. per sq.in.

Philadelphia, Pa. H. A. S. HOWARTH
Vice-President & General Manager
Kingsbury Machine Works, Inc.

READERS' PROBLEMS

QUESTIONS for Our Readers

CHECKING BEARING ALIGNMENT

Question 1

WE HAVE *a 500-kw., 4-bearing motor-generator set. I have reason to believe the bearings are out of alignment. Can alignment of these bearings be checked without taking out the rotor? If so, how? If the rotor must be taken out, what is then the best way to check bearing alignment?*—M. R. B.

CENTRIFUGING DIESEL LUBRICANTS

Question 2

WE HAVE *two 400-hp. diesels in our power plant, one operating continuously, the other coming in during peak-load periods. How often ought we to centrifuge our crankcase lubricating oil? Should it be allowed to settle first? Is there any advantage in adding water before centrifuging? If so, should the water be at room temperature or warmer? We have several opinions among our operators and would like to check practice of other stations.*—J. J. K.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Zero Soft Water

WE HAVE *a 1,000-sq.ft., H.R.T., Erie City boiler. Will you please advise us whether zero soft water is detrimental or not.* L. M.

(This reply was prepared for Power by William J. Ryan of the Water Service Laboratories, Inc., New York, N. Y.

Zero soft water is not detrimental to boilers by reason of its softness. However, some corrosion of the boilers may arise indirectly as a result of its use, unless the proper steps are taken to prevent it. The corrosion is caused by oxygen dissolved in the water. The soft water will not contain any more oxygen than the hard water, but when using hard water the scale deposits sometimes afford protection to the metal. Zero hardness water does not deposit scale, so the rusting action may occur.

The best remedy is to deaerate the feed water by means of an open heater, or apply internal treatment with sodium sulphite or some other material to react with the oxygen. Or a little hard water can be mixed with the boiler feed, just enough to deposit a very thin scale as a protection. This latter is the most practical for a small plant such as this.

As compared with this possible disadvantage, there is the great advantage that boiler scale and deposits can be eliminated by using soft water. This saves fuel and boiler-cleaning later. It also avoids the danger of damage by overheating to those parts of the boiler where deposits might accumulate.

SUPERHEATER CIRCULATION TO PREVENT OVERHEATING

ANSWERS to February Question 1

The Question

WE HAVE *6,000-sq.ft. cross-drum water-tube boilers in our plant fired with pulverized coal. Superheaters are behind the 5th row of tubes and give a steam temperature of 650 deg. at 250-lb. pressure. When starting these boilers up from cold, is it necessary to keep the superheater header drains wide open until the boiler is put on the line—this to produce circulation and prevent overheating the superheater tubes?*—V. D. N.

Connect Superheater With Auxiliary Steam Main

PROTECTION against overheating an interdeck type superheater when starting up lies in the quantity of steam flowing through the superheater and the screening effect of the boiler tubes between the superheater and the furnace. In this connction, it must be remembered that a 5-row water screen permits the superheater to "see" the radiant heat of the furnace.

With header drains open, there is no appreciable flow through the superheater when starting up until steam has formed and the steam drum pressure has reached 50 lb. or more. During this period, injurious temperatures may be encountered at the superheater if the firing rate is too high. Using pulverized coal, not more than 20 lb. of fuel per hr. per sq.ft. of water screen heating surface should be fired until the drum pressure reaches 50 lb. gage. After that the firing can be increased gradually as the steam pressure rises.

For positive superheater protection, the following installation and procedure is recommended:

1. Connect the superheater outlet header to the auxiliary steam line with an outlet to atmosphere or heater for draining condensate.
2. Connect superheater inlet header to atmosphere, heating system or other low pressure system. (These connections to be not less than $\frac{3}{4}$ in. inside dia.).
3. See that air cock is fitted in steam drum and air vents in the highest point in the downcomer from the steam drum to the superheater inlet.

When starting up:

1. Open air cock and air vents.
2. Drain superheater.
3. Cut in auxiliary steam to superheater outlet header.
4. When all air has been excluded from the system, close air cock and vents.
5. Build up pressure until it is at least 25 lb. above that in the low-pressure system.
6. Open connection from superheater inlet header. All air has now been excluded and there is flow through the superheater. Next:

1. Light burner in boiler.
2. When steam is formed and the drum pressure exceeds the auxiliary line pressure:

(a) Open outlet header drain wide.

(b) Close connection to inlet header and shut off auxiliary steam to outlet header.

(c) Keep outlet header drain open until boiler is put on the line.

In taking the boiler off the line:

1. Open superheater outlet header drain.
2. Shut off burners and close superheater outlet main stop valve.
3. Keep drain open until furnace refractory has lost incandescence.

This answer is based on a test I conducted. The boiler used was oil fired and similar in design to that described in the question. When starting up, gas temperatures at the superheater as high as 1,400 deg. were recorded. The firing rate given in the second paragraph above should not produce excessive temperatures.

Many factors such as furnace volume, number, size and location of burners and their proximity to the water screen tubes, have their effect on this question. In the absence of these data it is believed that the procedure given will afford ample protection.

U.S.S. Dallas L. G. BOCK

Superheater Not in Danger of Overheating

AS THE superheater is not in the direct path of the flame, there is little danger of it becoming damaged due to overheating when starting up the boiler. Superheater drains are usually opened wide until a few pounds pressure is raised. This allows the escape of air, dissolved oxygen, carbon dioxide and other gases that may be given off when the water is heated. When pressure starts rising, the drains may be throttled until they will bleed off any moisture that might accumulate in the header. Traps which discharge into a feedwater heater are usually installed on the superheater drains and are left cut in during operation of the boiler. This insures dry steam except in case of heavy priming or

foaming, and keeps the condensate out of the superheater header while the boiler is banked.

Waynesboro, Va. J. M. MYERS

Boiler Manufacturer Should Advise

IF THE manufacturer of V.D.N.'s boilers is thoroughly competent, he will have anticipated the problem and be able to advise V. D. N. on the method of superheater bleeding best adapted to these boilers.

In the event that this recommendation is not available, the difference between the cost of buying coal and replacing superheater sections surely dictates generous bleeding while warming up. Whether or not the superheater header drains must be kept "wide open" as the writer inquires, depends to a very large extent on the relative size of the drain lines. Boiler manufacturers generally do not install piping outside the boiler, and one cannot therefore predict accurately whether the drain lines are "full size" or not.

If V. D. N. is paying a high price for coal, and has many occasions to start boilers from cold, he may find it advantageous to install thermocouples at the headers. Continuous adjustment of the drain valves during the warming up process will then allow the steam temperature to be kept economically within the guarantee limitation.

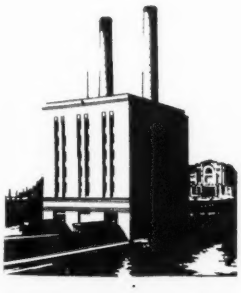
New York, N. Y. C. E. KEE

No Overheating

UNLESS otherwise specified, the superheater manufacturer usually supplies a ¾ in. drain valve with the equipment for a boiler of 6,000 sq.ft.

Under the conditions given, it is advisable to open the superheater drain and to leave it open until the boiler is cut in.

In a pulverized-fuel installation with only one burner, it is difficult to control the fire



during the firing-up period, making it necessary to operate the burner at high rating.

The superheater above the 5th row of tubes is well protected, and from my observation on quite a few installations there is no danger of superheater units becoming overheated.

If there is an observation or access door permitting an inspection of the superheater units during operation, I might suggest that after the fire has been started and is burning, say for 15 min., that it be shut off and the units observed through the inspection door. I am sure there will be no evidence of overheating.

Bogota, N. J. E. C. GRIEF.

Fill Superheater With Water

IT IS not necessary to have the superheater header drain valve open when raising steam. In starting up boilers that have superheaters, I close the superheater drain valve and open what we call a "flood valve" which permits filling the superheater with water from the boiler drum. The "flood valve" is left open until boiler pressure is raised to the header pressure, when it is closed and the superheater drain valve opened. When the water is all drained out, the valve is closed and the boiler is ready to be cut in on the line.

I have been water tender on a battery of 25 boilers of 500 to 1,000 hp., all equipped with superheaters, and this is the way we protected the superheaters.

Fort Wayne, Ind. JOHN L. WHITE

Effect of Temperature Cumulative

IN ALL of the plants where I have worked it has been the custom to open superheater drains not only when the boiler was being put on the line from cold but also after each bank. This was done to prevent burning superheater tubes. Starting with a cold boiler, it is at least half and hour before any steam is generated. During this time there is nothing to cool the superheater. If the boiler is brought from bank, the period during which there is no steam flowing through the superheater is short, but just the same, during this time there is nothing to protect the superheater tubes.

Sometimes an engineer forgets to open the superheater drain, and if there is no tube failure he may conclude that opening the drain is not necessary. But this conclusion is not justified, because the injury is cumulative and the failure may come after many failures to open the drain. The drain should be connected to the exhaust header so that the heat is recovered.

Chicago, Ill. N. T. PEF

ZONED HEATING A 30-STORY BUILDING

ANSWERS to February Question 2

The Question

I OPERATE *a zoned heating system in a 30-story building. Steam is distributed from the 17th floor to five zones, two zones for the radiators on the 18th to 30th floors and two zones for the radiators on the 4th to 17th floors. All radiators have inlet orifices but no return traps. There are two tenants, one on the 8th floor and one on the 22nd floor, that regularly work at night, and to supply heat to these two floors it is necessary to heat almost the entire building at night when otherwise steam would be shut off. If there were some way to supply steam to these two floors alone, very substantial economies could be made. I would greatly appreciate any suggestions from the readers of POWER on how this might be done.*—J. R. M.

Install Separate Lines from Boilers

I WOULD like to give you an outline of my experience with a problem of a similar nature. The scheme has been operating successfully for the past 4 yr. and not only has paid for itself as far as additional investment is concerned, but contributed to a considerable annual saving in heating expense.

The problem arose in a manufacturing plant comprising three single-story and two multi-story buildings of six and seven floors respectively. All buildings were piped to a 16-in. low-pressure main of approximately 1,000 ft. length with 8-, 10- and 12-in. risers to the top of each building. From these, heating was distributed in a down-flow system with risers 50 ft. apart, feeding radiators. While the plant was in full capacity, operation of this system worked rather satisfactory. During the last 4 yr. with the various departments working part time—some 3 days, some 4 days, some working 5 to 6 hr., some 7 and 8 hr. per day, the problem of supplying heat in proportional rates, economically, was becoming complicated. In addition to the variable working schedule it was found desirable to decentralize several office activities such as production, engineering, etc., and place them in factory areas for better cooperation and coordination of activities, which in turn again required different temperatures for ideal working conditions on the same floor. While a shop temperature of as low as 55 deg. and ranging up to 66 deg. is acceptable, no office temperatures are suitable below 70 deg. and with a predominance of female employees a temperature of from 72 to 76 deg. is more satisfactory.

To facilitate furnishing steam to approximately 15 distinctly different office areas where steam was needed, while the shop needed none, separate steam lines were laid, ranging in size from ½ to 2 in., according to requirement, and connected to the nearest supply of high-pressure steam (125 lb.) available for manufacturing purposes.

These pipelines from 100 ft. to sometimes 500 ft. long are connected through pressure reducing valves into the heating line with proper shut-off valves, so that the steam could conveniently be shut off when not needed in the summer time.

Approximately 50% of the radiators in the respective areas were disconnected from the regular heating system and connected to the new pipe line. This scheme allowed heating steam to be furnished with but a very small percentage of increase in the steam used for manufacturing purposes and kept the general heating lines cold until such times as it was absolutely essential to heat the factory floors.

It also facilitated heating the offices full time while the factory floors worked part

time, i.e. the general heating system could be shut down entirely, yet sufficient heat was available for all offices, so that they could work at all times in comfort. This reduced the general heating season from 4 to 6 weeks and reduced the heating cost about 40%.

Not knowing "J. R. M." problem in detail, for a satisfactory plan, I suggest the possibility of running a small separate steam line from his boilers to the 8th floor and one to the 22nd floor, and tie in these separate lines to the heating system through valves so either one or both supplies can be used without interference.

Yeadon, Pa. A. L. REIDL

Remove Orifices From All-Night Radiators

THE sound economic solution to a question of this kind is naturally dependent upon local building conditions, such as price paid for steam, number of hours at night the two tenants work, the permanency of the two tenants, etc.

There are several ways that could be used to heat the 8th and 22nd floors outside of office hours satisfactorily.

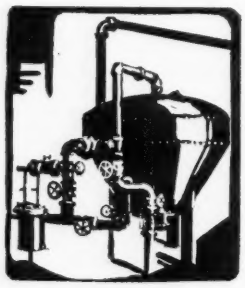
One method that is being satisfactorily used in a large Boston office building is to omit the radiator orifices of the radiators on the floor requiring all-night heat. The orifices in the rest of the building are 4-lb. orifices; that is, they require 4 lb. initial pressure completely to fill the radiator with steam. At night the steam pressure on the zone supplying that floor is carried at a few ounces, depending upon outdoor temperature, thus ample heat is supplied to the floor requiring heat at night. Yet the waste of heat is sharply reduced, because with 4-lb. orifices, only a small amount of steam is passed with an initial pressure of 2 or 3 oz. In the case in question, thermostatic traps would have to be installed on the radiators on the 8th and 22nd floors to prevent waste of steam through the return line during the daytime.

Another method would be to install separate lines to supply the radiators on those two floors requiring all-night heating. Permanency of the tenants and the cost of installing the separate supply pipes would have to be carefully compared with the expected savings before deciding upon this method.

Still another way would be to have portable (or permanent) electric or gas radiators for night heating. One large Boston hotel purchased three electric heaters recently for three of their permanent guests that always seemed to want more heat than the rest of the building. Substantial savings were made in steam used, and the good will of the guests was enhanced because they liked the idea of being able to turn on additional heat whenever they wanted it. However, when considering heating two entire floors, care should be taken to make sure that the electricity cost does not exceed the expected savings in steam.

One plan that would save steam during the daytime as well as at night would be to install remote-operated valves on each zone, for then at night two or three zones could be shut off, still leaving enough radiation turned on on the floors requiring all-night heat. These same valves could be used for daytime operation to compensate for wind and sun effects on the heating requirements. A further refinement would be to install remote-operated valves at the supply of each riser, then alternate risers could be turned on and off at will. For night operation, just enough risers would be left on to heat the floors requiring all-night heat; thus in moderate weather not more than half of them would be required.

A still further refinement would be to



install valves in the risers at the floors requiring all-night heat, thus permitting shutting off all steam below the 8th floor and above the 22nd floor at night.

To arrive at a sound solution of the problem, an estimate of the installation cost of the various methods proposed should be made along with an estimate of the net savings with each method. A comparison will show the best proposition from the standpoint of maximum savings with the minimum of investment.

Boston, Mass. R. M. NEE
Edison Elec. Illum. Co. of Boston

Use Electric Heaters

IT IS my belief that electric heating has the principal advantages and also is the most economical method for taking care of J. R. M.'s heating predicament. The two tenants' rooms can be effectively heated for occupancy outside of regular hours without the necessity of operating the entire heating system in this way.

By using electric heaters, no additional revamping need be made to the existing heating system. They would merely supplement it, and would be available during the night hours. The only additional cost would be the cost of the heater equipment and the energy cost. There should be no installation cost, as it can be reasonably assumed that the building is amply equipped with a sufficient number of large-capacity outlets.

No doubt a considerable concession in rates could be obtained from the utility company serving this territory, for the electric heating load to be taken during the off-peak period.

A study of the conditions existing in the building is essential before determining what type of heater should be installed. Possibly a radiant-convection type will prove most suitable.

A heating schedule could be arranged whereby the electric heaters would be connected for service immediately after the central heating system was banked for the night, thus the electric heaters are needed merely to maintain room temperature. For a slight additional cost a thermostat could be installed which would connect and disconnect the heaters if and when needed, and maintain the temperature within fairly reasonable limits.

To determine heater capacities requires detailed calculation of heat losses if proper results are desired. Reference should be made to the watt-loss tables for the various kinds of building materials given in E. A. Wilcox's book "Electric Heating" (McGraw-Hill Book Co., 1928), for determining the heat losses of the rooms. This heat loss, being determined in terms of watt-loss, determines the size and number of electric heaters.

Let me repeat that the total cost of electric heating would be the cost of the heaters and the energy cost. These costs should be weighed against the cost of revamping the present steam-heating system, or making necessary additions, and the coal consumption and hired labor cost for attending the furnace during these hours, if the present system is considered for adaptation.

But for convenience, cleanliness, safety, instant heat and uniform warmth, I feel that electric heating would fit this installation admirably.

No. Bergen, N. J.
KERMIT B. HOFFMAN

Install Unit Heaters

SEVERAL years ago I had a heating problem similar to the one mentioned, only on a smaller scale.

On the 17th floor of a 23-story office building was a railroad office that kept a telegraph operator on duty 24 hr. a day. As there were no other people working in the building heat was shut off at 6 p.m. unless the weather was very cold, consequently the telegraph operator complained about the lack of heat.

The heating system was an up-feed vacuum system, and the office to be heated was on a section that supplied two walls of the building. Thus I would have to furnish steam to about 35,000 sq.ft. of radiation to keep the telegraph room (14x18 ft.) warm.

I looked the job over with the idea of putting in an electric heater, but found I would have to put in a new run from the panel box on the floor about 100 ft. away. But as corridors were floored and paneled with marble, this didn't look good.

I then thought of the hot-water system and found a "live" column at the corner of the room, so we went to the floor above and took off a $\frac{3}{4}$-in. connection from the hot-water riser and to the floor below and cut into the circulating line. This was all done by breaking into the column in the office and fishing the pipe up and down.

A 25% over-size hot-water radiator was connected and worked fine. My thought in the present case is to pick out the "live" columns in the space to be heated and install unit heaters.

It may be necessary to pick up the circulating pipes from these columns in the basement or pipe space and connect them through a propeller pump to the heaters to get the proper circulation.

Chicago, Ill. C. G. HARDEN

THE ENGINEER'S BOOKSHELF

A.C. Principles

PRINCIPLES OF ALTERNATING CURRENT (2ND EDITION).—*By Ralph R. Lawrence, professor of electrical machinery, Massachusetts Institute of Technology. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. 475 pages, 5½ x 8 in.; cloth. 140 illustrations. Price, $4.*

This is a text developed from notes on alternating current used for several years by the author at Massachusetts Institute of Technology when teaching junior students in electrical engineering. The treatment is theoretical in which mathematics has been used freely. Subjects treated include algebra of vectors; circuits containing resistance, inductance and capacitance; Kirchhoff's Law; electric filters, polyphase voltages and currents; harmonics in polyphase circuits, unbalanced three-phase circuits; transmission lines, etc. Changes and amplifications have been made in the text as indicated by the author's and other teachers' experiences with the first edition. New material on even harmonics, coupled circuit and a brief chapter on electric-wave filters have been added.

Public Works

NATIONAL PUBLIC WORKS, AN INQUIRY BY THE LEAGUE OF NATIONS, (1934). *Published at Geneva. 281 pages, 8 x 10½ in. Paper cover. Available in United States from World Peace Foundation, 8 West 40th St., New York, N. Y. Price, $3.*

In most countries since 1929, public works programs have been initiated. This is a comparison, a result of continuous international study of general questions in which are reproduced replies of 29 governments to a request for detailed information sent out by the secretary-general of the League. The inquiry includes information on public works undertaken, principal administrative methods, methods of financing, allocation of expenditure between materials and equipment on one hand, and labor on the other, views of governments with regard to effects obtained or expected.

Types of projects included are classified as roads and bridges, railways, agricultural land and reclamation, canals and other inland waterways, land improvement work, drinking water supplies and sewage disposal, work on sea and river ports, airports, building work, electricity installations, gas-works and gas supply, telegraph and telephone installations and wireless broadcasting stations, and miscellaneous enterprises.

Diesel Handbook

DIESEL HANDBOOK (*2nd Edition*)—*By Julius Rosbloom. Published by Diesel Engineering Institute. 443 Hoboken Ave., Jersey City, N. J. 543 pages, 5 x 6½ in. Flexible covers. Price, $5.*

The second edition is almost 60% longer than the first (published about a year ago), the new material including certain illustrations and data on maintenance, plus two new sections, one on rules and regulations (60 pages) and one on tools and equipment (26 pages). The new illustrations are large and easily readable, and add much practical knowledge.

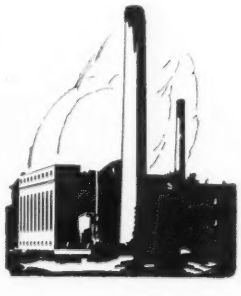
This reviewer still is inclined to criticize the obscure, and in some cases incorrect, wording, despite the practical fact that the book has been of such value that a second edition has been required within a year of issuance of the first—a very unusual circumstance. There is this to be said for the book—it presents much that is sound and practical in the easy-to-grasp question and answer style, and it discusses in one place or another almost everything a diesel engineer need know, from the simplest mathematics to the history of measuring instruments.

Motor Fuel

THE PRINCIPLES OF MOTOR FUEL PREPARATION AND APPLICATION (1935) VOL. 1. —*By Alfred W. Nash, professor of petroleum technology, University of Birmingham (England), and Donald A. Howes, Anglo-Persian Oil Co., Ltd. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 538 pages, 6 x 9¾ in. Cloth. 125 illustrations; 112 tables. Price, $7 (Vol. 1).*

This is a really authoritative text on a subject which, despite its tremendous importance, has been discussed in few worthwhile books. Not only are present-day subjects treated, but future problems are discussed. The work is directed toward the modern, high-speed, high-efficiency internal-combustion engine, and is of extreme interest not only to producer and refiner, but to the user. This volume deals with production of motor fuels by distillation, cracking, extraction from natural gas and hydrogenation, plus chapters on production of benzol, various synthetic fuels (including alcohol) and general storage and distribution. Vol. 2 will deal with properties of motor fuel, covering such subjects as sulphur content, gumming properties, volatility requirements, knock ratings, motor and aviation fuel specifications, and a chapter on automotive diesels and diesel fuel.

It is obviously impossible to review adequately a work of this magnitude in the limited space here available. For those interested in any phase of production or processing and application of fuels for spark-ignition engines, this is the book.



Brief Reviews

REFRACTORIES—*Technical bulletins of the American Refractories Institute, 1608 Walnut St., Philadelphia, Pa.*—Bulletin 52, "Reaction Temperatures Between Various Types of Refractory Brick," by Raymond E. Birch. 11 pages. Paper cover. Bulletin No. 56, "Red Hearts in Fire Brick and Fire Clay Shapes," by C. M. Dodd, and S. R. B. Cooke. Bulletin 51, "Insulating Refractories," by G. A. Bole.

A FEW BRIEF FACTS ABOUT MUNICIPAL ELECTRIC LIGHT PLANTS IN TEXAS. A 7-page *folder by R. B. George Engineering Co., Dallas, Tex.*—Detailed statistics on each of 36 plants, figures being taken from auditor's reports or other authentic sources.

SMOKE ABATEMENT—*Two reports of the Smoke Abatement League, 2901 Union Central Bldg., Cincinnati, Ohio, Attention Frank H. Lamping, Supervisor.*—22-page typewritten report, "Smoke and Soot Pollution Analysis," by Frank H. Lamping, and 8-page Annual Report of Supervisor of Smoke Abatement.

CLASSIFICATION OF COALS. *A report of a Sectional Committee of American Society for Testing Materials, 260 South Broad St., Philadelphia, Pa. 27 pages.*—This report proposes tentative specifications for classification of coals by rank and grade.

MECHANISM OF COMBUSTION OF COAL. *By Martin A. Meyers. Technical Publication No. 575 of the American Institute of Mining & Metallurgical Engineers, 29 West 39th St., New York, N. Y.*—A 17-page reprint of a technical paper.

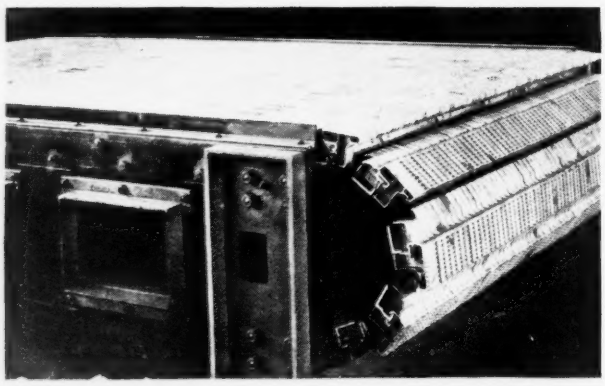
LUBRICATING OIL TESTS—A PRACTICAL INTERPRETATION OF THEIR SIGNIFICANCE. *By James I. Clower, assistant professor of machine design. Published by Bureau of Public Information, Virginia Polytechnic Institute, Blacksburg, Va.*—A bulletin of exceptional interest and value to power plant operators and purchasing agents, and available free to inquirers.

DIRECTORY OF THE REFRACTORIES INDUSTRY. (1935) *Published by American Refractories Institute, 1608 Walnut St., Philadelphia, Pa. 50 cents per copy, less 50% discount to members.*—This ninth edition presents in convenient form information relative to brands, products and plants of members of the Refractories Industries in the U. S.

ELECTRICAL YEAR BOOK (1935). *Published by Emmott & Co., Ltd., 31 King St., W., Manchester, England. 370 pages, 4 x 6 in. Cloth. Price, 1/6 net.*—Includes a new section on rectifiers, plus the former general information for electricity users and electrical engineers, and a day-by-day diary.

L'ALLUMAGE DES MOTEURS À EXPLOSIONS PAR BOBINE D'INDUCTION (SPARK IGNITION SYSTEMS FOR INTERNAL-COMBUSTION ENGINES). *By A. Boury and A. M. Touvy. Published by J. B. Bailliere et Fils, 19 Rue Hautefeuille, Paris, (6e France. 274 pages, 4¼ x 7 in. Flexible paper cover. 166 diagrams. Printed in French. Price, 38 francs.*—A French handbook, giving very complete coverage on European ignition systems.

WHAT'S NEW IN PLANT EQUIPMENT



STOKER GRATE CLIPS

HARRINGTON stoker grate clips (new style) can be applied to existing stokers without changes other than replacement of bolts which hold grate angles to grate chain links. Give more uniform air distribution over entire grate surface and minimize air leakage at side. Increase capacity 10 to 25%. Reduce siftings and maintenance. As clips go over rear of stoker (shown in illustration) leading end is always ahead of trailing end so ash cannot get on under side of clips to be carried around to front.

Riley Stoker Corp., Worcester, Mass.

AUTOMATIC CONTROL

POTENTIOMETER Stabilog combines temperature measurement features of potentiometer system with control advantages of Stabilog system. Will control temperatures up to 2,800 deg., without hunting and over-controlling, and is free from manual auxiliary adjustment. Case has double doors outer gasketed for protection against fumes and dust, inner one operating panel. Universal aluminum case for either wall or flush mounting. To transmit temperature changes (changes in galvanometer position) to flapper valve, a calibrated detector arm is constantly being lifted and lowered by a lifter. When arm is raised galvanometer pointer may deflect in either high or low direction, depending on temperature change. Direction and amount of deflection determines distance detector arm may be lowered. Should temperature tend to rise, galvanometer will deflect to high side of scale, allowing detector arm to be lowered further than on previous cycles. As arm descends it engages a rocker which turns flapper shaft and adjusts flapper valve of Stabilog mechanism. This readjusts controlled valve opening sufficiently to keep temperature constantly at control point. When temperature tends to fall, galvanometer will be deflected toward low side of scale, preventing detector arm from descending as far as previously. In this case, lifter engages other side of rocker and turns it until it is stopped by detector arm. This adjusts flapper valve of Stabilog mechanism, which in turn closes control valve as required.

Foxboro Co., Foxboro, Mass.

COMPENSATED BELT

PATENTS have been granted on Condor compensated belt, which by virtue of its construction equalizes ply stresses when belt flexes around pulley. Patent awards exclusives rights of manufacture to:

Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J.

CABINET-TYPE STEEL METER PANEL

EQUIPPED with doors to protect and conceal meter and control connections. Doors have 3-point locking mechanism and substantial cylinder lock. Door panels durable, made of 1-piece sheet steel plates formed to give proper appearance. Self-supporting construction by bending sides of panel to form supporting wings. Base flange drilled at convenient intervals for molding or lagging, if desired. Flange may be concealed within cabinet by bending both front and wings inward to 90-deg. angle. Black finish, but looks like slate or composition.

Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio.

HARD-METAL ELECTRODE

"ABRASOWELD" hard-surfacing electrode is designed for building up straight carbon steel, low alloy or high-manganese steel surfaces to resist abrasion. Maximum hardness only at surface where it is cold-worked. Moderate peening raises hardness to about 50 Rockwell C, and surface must be ground to shape. Also resistant to corrosion, and deposits can be forged hot. $\frac{3}{16}$-in. size, 14 in. long, used with reversed polarity with current range of 125-200 amp., and 24-27 arc volts.

Lincoln Electric Co., Coit Road & Kirby Ave., Cleveland, Ohio.

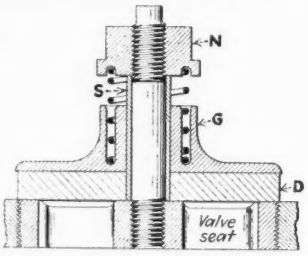
CENTRIFUGAL PUMPS

TWO larger sizes "Monobloc," 3-in. and 4-in., are essentially similar in design to smaller (1 to $2\frac{1}{2}$-in.) units. Pump, besides being rigidly mounted on motor frame, is supported by foot resting on base. Pump impeller mounted directly on motor shaft, and both pump and motor bolted to one rigid base to relieve pump from possible pipe strain. Improved impeller renewable wearing rings, and balance rings to eliminate end-thrust and put stuffing box under suction pressure only. Variety of material combinations. Fittings standard bronze, all bronze or all iron. Electric characteristics standard or special. Motor construction splash-proof or special type. Mounting either horizontal or vertical. Bulletin W-321-B4.

Worthington Pump & Machinery Co., Harrison, N. J.

PUMP VALVE WITH MALIKITE DISK

DISK *D* is "Malikite," a tough material composed of canvas impregnated with a Bakelite compound. Held tightly to its seat by bronze spring and brass guard



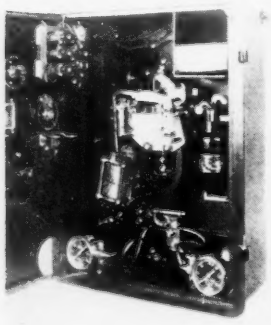
G. Guard is deeply recessed to prevent distortion of spring and to insure constant and uniform loading of valve. Nut *N* also recessed to center spring around valve stud. Sleeve *S* prevents stud wear, and may be readily renewed when necessary.

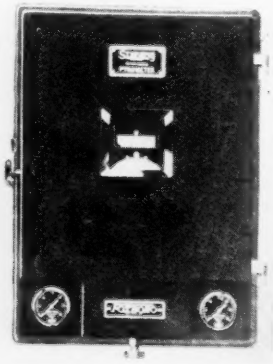
J. C. Edgecumbe Co., 295 Pearl St., New York, N. Y.

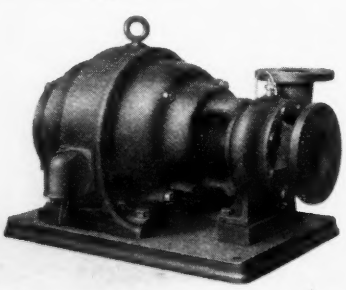
AIR NOZZLES

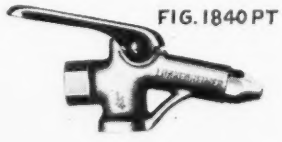
BRONZE nozzles with renewable non-metallic disks, one with integral hose end (Fig. 1840-PT), one with female pipe end (Fig. 1841-PT), either pattern with pointed, flat or extension tip. Used for blowing dust, dirt, sand, liquid deposits and other matter. Disk specially compounded for air service. Unrestricted flow area permits free passage through nozzle of scale and grit that might be carried with air from pipeline. Lower brace provides opening for hanging nozzle on rail or hook when not in use. Booklet F-533A.

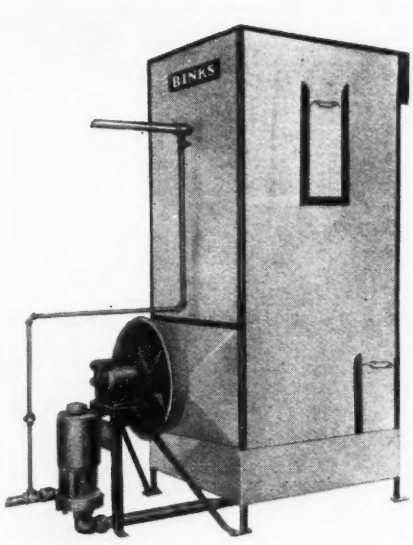
Lunkenheimer Co., Cincinnati, Ohio.

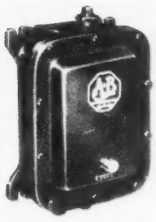


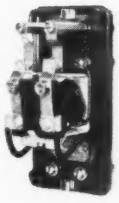












INDOOR FORCED-DRAFT COOLING TOWER

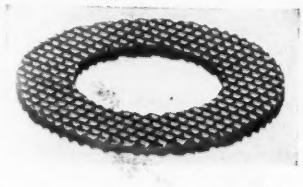
EIGHT sizes, ranging in capacity from 5 to 150 g.p.m. circulation. Recommended for cooling and condensing circulating water for refrigeration equipment and other industrial processes. Simple design and construction. Tower housing heavy-gage galvanized copper-bearing steel with interior air deflectors to insure uniform air distribution from fan unit. Fan aluminum alloy. Warm water delivered to tower from condenser or other process to a system of patented "Rotojet" clog-proof nozzles, arranged to provide maximum water breakup and distribution under low pressure, and to insure maximum cooling effect. Two smallest sizes (5 and 10 g.p.m. capacity) furnished as complete self-contained units; larger sizes made up in sections assembled on job. All sizes furnished with fan and fan motor, together with water circulating pump where desired. Automatic operation where necessary. Bulletin No. 70.

Binks Mfg. Co., 3114-40 Carroll Ave., Chicago, Ill.

GASKET

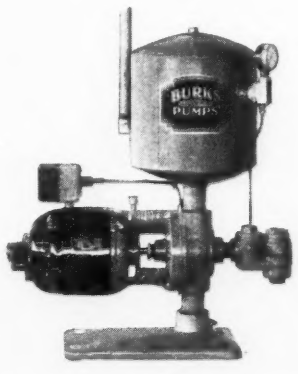
MULTISEAL metallic or semi-metallic gasket to withstand pressure, temperature change and vibration, designed to produce perfect tightness with only 30% as much contact surface as on plain flat metal gasket, thus will greatly reduce bolt pressure. This is accomplished by providing faces with crossed ductile and resilient raised ribs, which under small bolt pressure are said to set themselves into tight contact even on imperfect flange faces. Solid copper, steel, Armco iron, aluminum or lead, or as metal shell with asbestos filler, and in any circular, elliptical or special shape.

Goetze Gasket & Packing Co., New Brunswick, N. J.



WATER SYSTEM

SERIES 8780 complete water system in four sizes of 200 or 300 g.p.m., using 1/6- and ½-hp. motors, respectively, and operating on 60-cycle a.c., odd cyclages of a.c., or 32- or 110-volt d.c. Total head, including suction lift and friction loss, 50 lb. per sq.in., or 115 ft. 28-ft. guaranteed suction lift. Self-priming. Continuous discharge. Direct drive. Stainless steel shaft in oversize ball bearings. Impeller and raceway cast bronze. Base and pump case galvanized cast iron. Usual storage tank 4 gal., but may be used as



feeder for large storage tank. Automatic air volume control. Automatic overload motor disconnect.

Decatur Pump Co., Decatur, Ill.

SOLENOID SWITCH FOR HAZARDOUS GAS

TYPE G explosion-proof inclosures (formerly available only for Size 1, Bulletin 709, solenoid-operated across-the-line switches) now available for Sizes 2 and 3 switches for polyphase motors up to 15 hp. 110 volts, 30 hp. 220 volts, and 50 hp. 440-550 volts, and for self-starting, single-phase motors. Meets Underwriters' requirements for Class 1, Group D, hazardous gas locations.

Allen-Bradley Co., 1311 South First St., Milwaukee, Wis.

AUXILIARY RELAY

SMALL, sturdy, low-priced, a.c. or d.c., switchboard or panel mounting. Type SK for switchboard mounting has molded cover or molded cover with glass front; panel-mounted unit has no cover. Both have two independent contact circuits adjustable for circuit-closing or circuit opening. Continuous duty at rated voltage up to 550 volts a.c. or d.c.; ranges to 250 volts for intermittent duty up to three times continuous value. Coil supplied for current value to 5 amp. Suitable for any thickness of panel material from ⅛-in. steel to 2-in. slate. Molded terminals 1⅛ in. long.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

PISTON PUMPS

LIQUID and side pot type with minimum clearance and removable cylinder liners. Accessible, long-lived, and interchangeable wearing parts. Liquid valves in pots on cylinder sides give streamline flow from suction to discharge. Liquid cylinders compact and rugged for discharge working pressures up to 500 lb. per sq.in. in Wompco metal, and 700 in cast steel. Chrome alloy valve service and liquid-end piston rods, and Ni-Resist cylinder liners are standard. Cast-iron pistons with hammered iron or fibrous packing rings may be fitted. For pumping oils or distillates at temperatures above their flash points, the side pumps are fitted with deep water-jacketed stuffing boxes. Valve service, cylinder liners, liquid pistons and packing are interchangeable between simplex and duplex pumps of the same bore and stroke. Units available as simplex and duplex steam-driven, or duplex power pumps driven by steam, gas or diesel engines or electric motors, either direct-connected or through multi-V-drive. Bulletin Q-110-B2.

Worthington Pump & Machinery Co., Harrison, N. J.

CORK TILE

WIDE range of standard and special sizes in light, medium and dark brown of varying shades and two thicknesses. ⅜-in. thickness weights 20 oz. per sq.ft.; 9/16-in. 33 oz. per sq.ft.; and these thicknesses can be sanded down to ⅛ and ½ in., where required. Also coved angle and wall base, as well as special heavy-density Corinco cork tile nosing for stairways. Suitable for deadening all types of floors.

Cork Insulation Co., Inc., 155 East 44th St., New York, N. Y.

CONVERTIBLE MOTORS

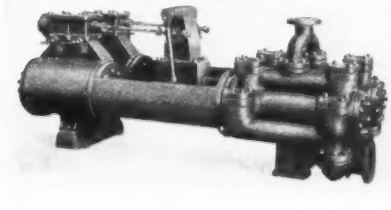
SQUIRREL-cage and slip-ring induction motors in all standard frequencies, 110-220 volts. Built to N.E.M.A. standards, readily convertible to open or fan-cooled, splash proof or totally enclosed types through special design of frame, end heads and bearings stator laminations stacked between heavy steel end rings, then assembly is welded to frame. ½ hp., 600 r.p.m., to 125 hp., 3,600 r.p.m. Bulletin HM1.

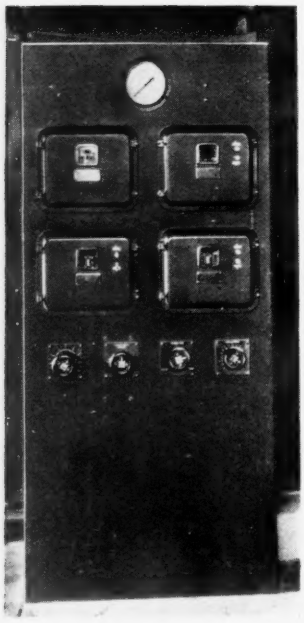
Harnischfeger Corp., West National Ave., Milwaukee, Wis.

SOLENOID-OPERATED OIL-IMMERSED SWITCH

TYPE H (explosion-proof) and Type J (general application) inclosures for sizes 2 and 3 switches of Bulletin 709 solenoid-operated across-the-line starters. Starters equipped with these inclosures will take care of any polyphase motor requirements up to 15-hp. 110 volts, 30-hp. 220 volts, and 50-hp. 440-550 volts, as well as self-starting, single-phase motors. Type H meets Underwriters' requirements for Class 1, Group D, hazardous gas locations. Type J used where oil immersion is required only as protection against corrosive gas.

Allen-Bradley Co., 1311 South First St., Milwaukee, Wis.





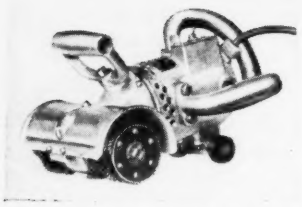
COMBUSTION CONTROL UNIT

"METERMAX" control is a unit ready for installation. An improvement of L&N metered combustion control. Maintains air-loading pressure in definite relation to steam demand and balances against this pressure-metered supplies of fuel and air to each boiler. Electricity is power medium to permit use of large reliable drive units and to simplify connections between panel and drive. Individual metering action. Four controllers of primary simplicity, ready-mounted and connected on a panel. Master controller connects to all boilers and balances steam pressure against air-loading pressure. Fuel-feed controller, air-flow controller and furnace-pressure controller at each boiler are simple mechanical balances with but one moving element, and each has integral push-button built into case. Only connection between panel and drive unit is a conduit carrying control wires. Below controllers on panel are fuel-air rheostat, load adjustment valve, transfer valve and selector switch, suitable for small boilers as well as large. Circular F-172-T.

Leeds & Northrup Co., Philadelphia, Pa.

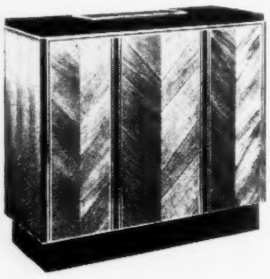
STEEL-CLEANING TOOL

MODEL "M" "Berg" cleaning tool cleans off heavy rust, scale and foreign accumulations, cuts down through pitted cavities. Prepares surface for adhesion of new paint. Simple to operate. 72 loose cutters mounted in cutter bundles are thrown out by centrifugal force at 115,000 impacts per minute. Degree of impact regulated by a depth shoe easily adjusted.



Electric unit illustrated has G.E. ½-hp. universal motor, grease-seal ball bearings, similar accessories. Larger size than former Model K.

"Berg" Cleaning Tool Division, Concrete Surfacing Machinery Co., Cincinnati, Ohio.



PORTABLE AIR-CONDITIONER

SELF-CONTAINED air-conditioner provides for cooling, dehumidifying, cleaning, circulating and freshening air. Genuine walnut panels and satin chrome trim on cabinet. Conditioner designed to be placed beside a window and has telescopic duct connection in rear from which outside air is drawn in, and also for cooling refrigerant condenser. Mounted on rubber-tired ball-bearing casters. No need of water supply and drain pipe. Condensed moisture from evaporator is drained to condenser air stream and there re-evaporated by new type condensate vaporizer which operates between divided sections of air-cooled condenser. 2-cyl. $1\frac{3}{4}$x$1\frac{3}{4}$-in. Freon compressor mounted above ¾-hp. motor for compactness and rigidity, driven by V-belt and has cooling capacity of about ⅝ ton of refrigeration. Evaporator is single-pass, hot-tin dipped, copper-fin coil. 9-in. radial fan circulates 270 cu.ft. of room air per min., of which 25% may be fresh air from outside. Cleanable filters on both fresh air intake and on recirculated air intake.

York Ice Machinery Corp., York, Pa.

RENEWABLE GATE VALVES

SEATS can be renewed by one man in 5 min. without removing body from line. All parts interchangeable. Several types. Gate or wedge is solid, will not warp or spring. Unrestricted pipe opening, heavy walls and diaphragm.

Fairbanks Co., 393 Lafayette St., New York, N. Y.

FORGED-STEEL STRAINER

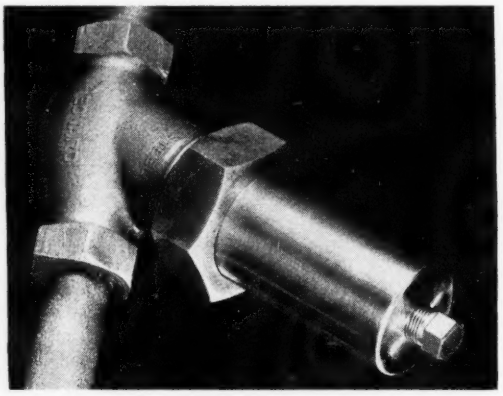
DESIGNED for high pressure-temperature service, but available for lower pressures and temperatures also. Bodies heat-treated and accurately machined with full aligned threaded pipe ends. Standard removable strainers perforated monel metal. Threaded pipe plug provided through which accumulated foreign matter may be blown out. Screen dimensions proportioned to give flow area through perforations of about 7 times pipe area in order to reduce cleanings. Catalog 11-G4.

Edward Valve & Mfg. Co., Inc., East Chicago, Ind.

HARDFACING ELECTRODE

"TOOLWELD" provides a deposit equivalent to high-speed tool steel which retains hardness of 55 to 65 Rockwell C under relatively high temperatures up to about 1,000 deg. F.; 14-in. lengths in four sizes, 3/32, ⅛ in., 5/32 in. and 3/16 in. Packed in 5-lb. containers.

Lincoln Electric Co., Coit Road & Kirby Ave., Cleveland, Ohio.



CLIP-TYPE GATE VALVE

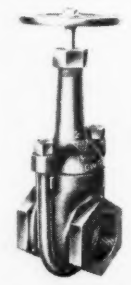
VALVE has round bonnet, therefore differs essentially from convential clip gate valves. Round bonnet construction permits use of male-and-female joint with asbestos gasket assuring tightness. Full U-bolt holds bonnet joint tight. Three sets of guides on body and two solid eye lugs on bonnet hold U-Bolt. Full-thickness I-beam cast wedge brings sturdiness to valve seat and permits use of full-size body guides. Horseshoe connection assembles spindle and wedge. Guide slots in wedge machined. Valves all-iron or bronze mounted.

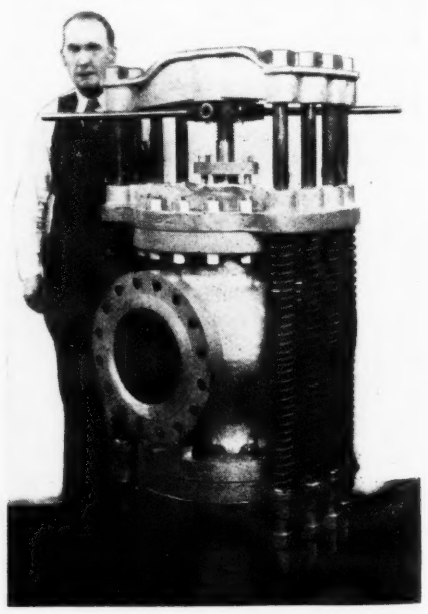
Reading-Pratt & Cady, Inc., Bridgeport, Conn.

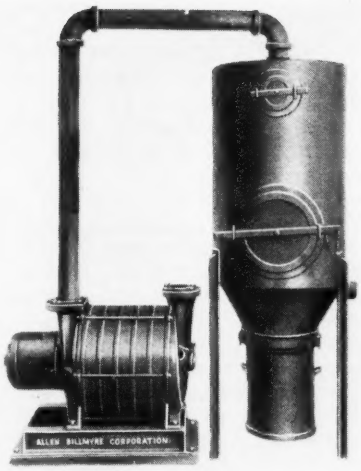
SINGLE-SEAT VALVES

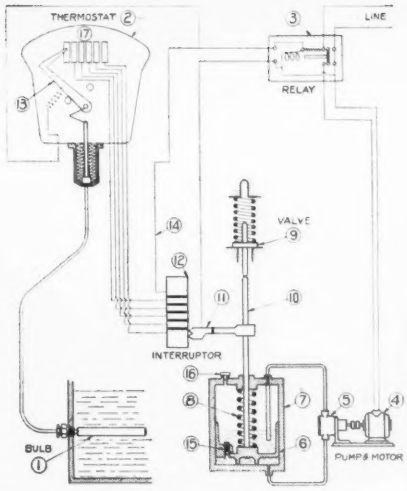
BUILT of steel throughout for 600-lb. pressure, standard. Use to protect headers and boilers against losing pressure, in case of rupture in structure beyond valve. Any reverse flow through closes disk. Dashpot prevents shock closing. As valves are bottle-tight, they can also be used to effect shut-off in place of motor-driven or hand-operated gate valves. Illustration shows one of two 10-in. units installed at Philadelphia plant of Container Corp. of America, one set to open at 55 lb.; other at 205 lb. pressure.

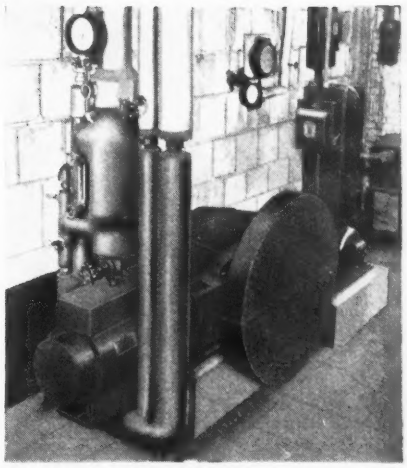
Davis Regulator Co., 540 S. Washtenaw Ave., Chicago, Ill.











HEAVY-DUTY STATIONARY VACUUM-CLEANING SYSTEM

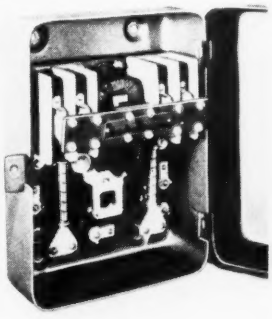
MODEL FB vacuum producers driven through flexible couplings from either a.c. or d.c. 50- or 60-cycle motors or steam turbines. Belt drive available for applications where current is under 60 cycles. Consists of centrifugal exhauster, separating system composed of one or more large tanks, one containing filters, set of cleaning tools, flexible suction hose, piping system (made up of standard pipe and fittings). Tools to fit conditions.

Allen Billmyre Corp., South Norwalk, Conn.

A.C. MOTOR STARTERS

INTENDED for use with squirrel-cage motors or as primary contactor for wound-rotor (slip-ring) motors in conjunction with suitable secondary rheostats. Automatic reset overloads, manual reset overload operative from button in cover, start and stop push button in cover, hand-off automatic switch and reset button in cover, fusible or unfused disconnect switch. Thermal overload relay, which is incorporated, is compensated so that wide variations in ambient temperatures do not affect operating characteristics. Relay rating can be changed quickly by inserting proper heating elements to handle any load condition within starter range.

Monitor Controller Co., 51 S. Gay St., Baltimore, Md.



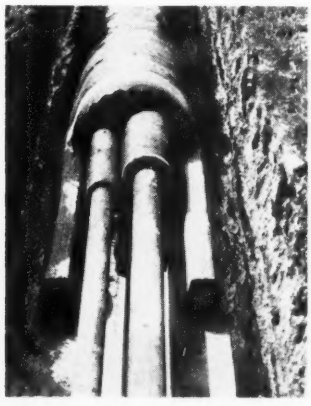
TEMPERATURE REGULATOR

THIS system of temperature control consists of electric thermostat of a liquid expansion type equipped with commutator switch carrying six separate contacts. Thermostat operates valve actuator consisting of a piston moved up and down in a cylinder by oil pressure generated by a motor-driven impeller pump. Motor started and stopped by thermostat so that valve adjusts itself to a throttling position between open and closed just sufficiently to maintain desired temperature. Instrument suitable for temperatures of 50 to 950 deg., and can be used with valves suitable for steam, water, oil, gas or brine. Both thermostat sensitivity and speed of valve travel are adjustable by user, so that control can be synchronized accurately with heat cycle. Motive power to operate single-seated valves of any size from $\frac{1}{4}$ to 16 in.

Wilbin Instrument Corp., 40 East 34th St., New York, N. Y.

UNDERGROUND STEAM CONDUIT

"THERM-O-TILE" is claimed more practical, durable, and efficient than earlier types. 4-in. concrete base poured directly in trench bottom, conduit and piping resting independently on this base. No broken stone fill or underdrain. Drain channel in center of base closed against anything other than seepage or pipe leakage. Pipe lines supported by special cast-iron adjustable supports independently of tile envelope, to avoid strain on conduit joints. All tile sections double thickness with integral air spaces, base sections trapezoidal, to give rigid support in top arch and furnish large air spaces. Top arch constructed without ball joints, giving smooth exterior for waterproofing when required. All joints designed so that cement used for sealing is locked into grooves and cell. Strong concrete base and strong tile sections resist crushing loads, permitting tile to be installed closer to surface, reducing cost of excavation, eliminating cast-iron sections and avoiding necessity for concrete arches under roadways. Size and shape can be varied to meet any conditions by choosing proper height of base section and best diameter of tile envelope. Base sections vary in height from 6 to 12 in., in increments of 2 in., while top tile envelopes vary from 9 in. to 24 in. diameter in increments of 3 in. Any base may be used with any envelope.



H. W. Porter & Co., Inc., 825 Frelinghuysen Ave., Newark, N. J.

NEW MONEL METAL

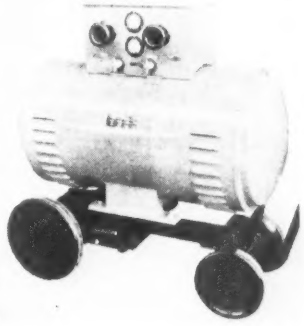
K MONEL combines strength of alloy steels with corrosion resistance of regular Monel metal. 4% aluminum and fractional amounts of other elements added to regular Monel. Readily heat treated to above 350 Brinell. Tensile above 160,000 lb. per sq.in.

International Nickel Co., Inc., 67 Wall St., New York, N. Y.

STEAM BOOSTER COMPRESSORS

TAKES steam from existing boiler system, raises pressure beyond capability of boiler itself and distributes it to points of demand. Suitable control so that steam pressure or temperature can be regulated within close limits. Drive either steam or motor with multi-V. Double tapered roller main bearings except in large sizes. Automatic lubrication and mechanical force-feed cylinder lubrication. Cylinder and head insulated. Bulletin L-611-B3.

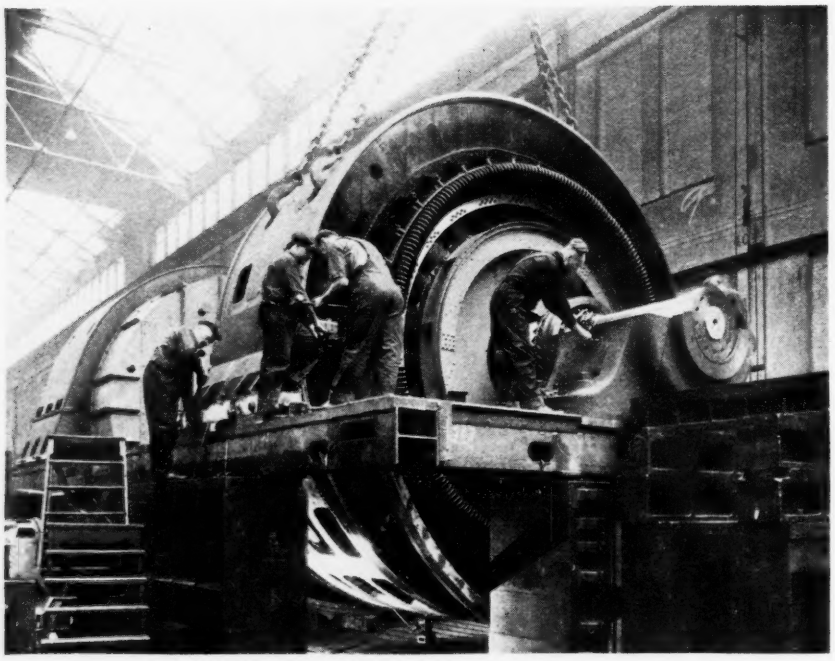
Worthington Pump & Machinery Corp., Harrison, N. J.



ARC WELDER

UNITY power factor motor drive is claimed to provide 10 to 15 per cent better over-all efficiency than conventional machine. Separate auxiliary differential field structure produces improved welding importance. Oscillograph tests show recovery from short circuit to normal welding current in less than 0.01 sec. Unit will maintain current and voltage settings when started up cold, and run full load for any period desired. Temperature rise has no effect on current and voltage setting. Both 25- and 40-volt operation by simple adjustment, permitting use of improved high-speed coated rods, as well as standard rods, and also allows copper arc and carbon electrode work. All-steel welded construction, dual control system, polarity reversing switch and zero center individual current and voltage meters. Also for motor or engine drive. Noel "Speed Arc."

Ideal Electric & Mfg. Co., Mansfield, Ohio.



FREQUENCY CHANGER SET FOR CONSOLIDATED

A duplicate of a set installed in 1930, this frequency changer is being built in the Westinghouse East Pittsburgh shops for Consolidated Gas & Electric Co. It is rated at 30,000 kva., 300 r.p.m., and will convert 3-phase, 13,800-volt current from 60-cycle to 25-cycle for the City of Baltimore. Power will be supplied chiefly from Safe Harbor.

POWER LINES

E.C.P.D. to Accredit Schools and Certify Engineers

Broad plans for accrediting engineering schools, certifying engineers as professionally competent, and training engineers almost from the cradle to the grave, were outlined by four eminent engineers March 7.

Presenting the objective of the Engineers Council for Professional Development, Gano Dunn, President of J. G. White Engineering Corp.,; C. F. Hirschfeld, chairman of the Council and chief of research of Detroit Edison Co.; Gen. R. I. Rees, assistant vice-president of A.T.&T., and Dean J. W. Barker, of Columbia School of Engineering, spoke in New York before the Metropolitan Section of five national engineering societies representing civil, electrical, mechanical, chemical and mining engineering.

E.C.P.D. has been organized by seven national engineering groups representing the technical, social, educational and legal aspects of the engineer's life. The engineer will get recognition from the world at large, said Dr. Hirschfeld, when he makes himself a sufficiently well-trained broad-visioned, generally capable person.

"The work of the Council begins with the prospective engineering student, considers the fundamentals of his technical, social and economic training, follows him through his early post-college years, and, finally examines his fitness for recognition as a well-rounded engineer," according to Dr. Hirschfeld.

Engineering schools are to be accredited by a committee of the Council, it was stated, not for standardizing engineering education, but rather to discover weaknesses in our educational structure and improve the quality of teaching. According to Dr. Hirschfeld, definite plans for "post-graduation" education are being developed.

General Rees said that the committee plans to organize senior engineers throughout the country as consultants and advisers to younger men who are undertaking the program of professional development.

To guard the professional title of engineer, the Council proposes to serve as a single body to examine who is qualified to practice as an engineer and use the professional title. A system of special examination will probably be put into effect gradually over a period of years.

Chemical Industries Reach 300th Year

The Chemical Industries of America will celebrate the 300th anniversary of their founding this year, with events opening in New York, April 22, at the 89th meeting of the American Chemical Society, in which the Manufacturing Chemists Association, Synthetic Organic Chemical Manufacturers Association, and chemical societies of the metropolitan district will participate.

National Power Survey Released Soon

The interim report of the Federal Power Commission's National Power Survey is soon to be released. It discusses development of electric power, power requirements upon resumption of pre-depression industrial activity, adequacy of present power production facilities, surplus and deficit of dependable capacity in each major zone, power plants recently completed or at present under construction, value of coordination in a regional power supply, undeveloped water-powers, fuel resources, relation of water fuel-generated power, interstate transfers of power, importance of power in the national defense.

Results and summaries are based largely on returns of the 215 largest utility systems, comprising 391 properties privately owned, and 21 major municipal plants, which together represent 93% of the country's generating capacity and 96% of its total output.

Floating Power Show to Visit Buffalo, Cleveland, Detroit

Conventions afloat have been held before, but never a floating power show, according to Ernest H. Smith, managing director of the projected Great Lakes Power & Mechanical Exposition, June 24-28. Mr. Smith has announced that the lake steamer, *Seeandbee* will be chartered to carry the show to Buffalo, Cleveland and Detroit.

The exhibits, Mr. Smith announces, will be placed aboard ship at Cleveland. On the night of June 24 the show ship will proceed to Buffalo and dock there for the day. From 10 a.m. until midnight it will be open to the engineering public of the city. The traveling exposition then returns to Cleveland for June 25, sailing for Detroit at midnight. After a full day in Detroit, the *Seeandbee* returns to Cleveland for dismantling.

The *Seeandbee*, especially rebuilt and redecorated for the Exposition, can accommodate 200 booths. Power equipment, materials and supplies are to constitute the chief items on display. Exhibitors will live on the boat and use their staterooms as private offices. 200 visitors may be accommodated on the boat. Power is to be furnished by the ship's own power plant. Headquarters of the Exposition, and of Mr. Smith, are 3910 Carnegie Ave., Cleveland, Ohio.

National Society Officers to Meet May 20

Officers and directors of the national societies of civil, mining and metallurgical mechanical and electrical engineers, and of their several jointly sponsored functional organizations, will meet together for dinner May 20 at the Engineers' Club in New York, according to plans recently announced by United Engineering Trustees, Inc. This is the first time in the history of the Societies that any such meeting has been undertaken. It is planned to establish a clearer and broader understanding of the scope and significance of work carried on jointly by the several participating societies. Joint work includes United Engineering Trustees, Inc., and its two departments, Engineering Socie-

ties Library, and Engineering Foundation, American Standards Association, Division of Engineering and Industrial Research of the National Research Council, Engineering Societies' Employment Service, and Engineers' National Relief Fund, American Engineering Council, Engineers' Council for Professional Development.

7th Midwest Power Show at Chicago, Oct. 14-18

The 7th Midwest Engineering & Power Exposition will be held at Chicago, Oct. 14-18 of this year, covering power generation, electrical equipment, boiler room accessories, refractories, fuel-burning equipment, hydraulic water-softening, regulation and instruments, ventilating, cooling and heating and accessories, building and operating materials and accessories, power distribution, power transmission, lubrication, and diesel power. The last exposition was held during Engineering Week in 1933. G. E. Pfisterer is managing director with offices at 1 North La Salle St., Chicago, Ill.

A.S.T.M. Committee Week

A.S.T.M. Committees participating in group meetings of committees in Philadelphia, March 4-8, held about 130 meetings and discussed a number of problems which are of interest to power engineers. A number of revisions, consisting of additions to the range of sizes and gages up to and including 10 in. outside diameter, and deletion of sizes over 10 in. outside diameter, were asked in tables of Specifications for Lap-welded and Seamless Steel and Lap-welded Iron Boiler Tubes (A-82-34). A proposal to substitute manufacturing weights for the present theoretical weights was considered, but the revised tables will continue to carry theoretical weights as heretofore. Clarification of marking requirements in this same specification was approved.

Specification requirements are to be drafted covering electric-resistance-welded boiler tubing. Proposed specifications covering nuts, bolts and forgings for service at temperatures from 750 to 1,100 deg. F. have been drafted, but a number of changes are to be incorporated. This may be in shape for publication as tentative later this year. Committee D5 on Coal and Coke approved three methods of tests, subject to approval for presentation to the Society as tentative; a method of test for screen analysis of coal, and tests for grindability of coal by the Hardgrove-machine method, and by the ball-mill method. The committee voted to recommend adoption as standard of the present tentative method of sampling coke for analysis (A 346—33T).

The committee on coal classification met in New York in February. Seven charts listing all uses of coal, with chemical, physical properties of importance in selection of coal for any specific use, have been prepared and will be submitted to the men best qualified to pass on relative importance of properties for correction. The boundary line of 77% fixed carbon between the first and second groups of coal of the bituminous class, as given in tentative specification for classification of coals by rank (D 388—34T) was revised to 78% fixed carbon.

German Boiler Industry Display Activity

Interesting data concerning activities of the German steam boiler industry during the past two or three years were revealed in a lecture at Essen, Germany, by Dr. Friedrich Schulte, president of the Association for Supervision of Power Equipment in the Ruhr coal mines. Dr. Schulte set forth that the depression had sorely tried the industry, but that idle time thus made available had been utilized for extension of research work with a view to improving products. Results have been highly satisfactory. Business is on a much higher level and present employment is brisk.

Considerable success has been had in production of high-pressure equipment, embodying increased efficiency. Special steels with high tensile strength have been used. While water-gas welded equipment predominates, electrically welded equipment is gaining ground, while riveting has almost disappeared. The general tendency has been one of simplification. This simplification is claimed to have been carried so far that efficient high-pressure boilers now cost but little more than low-pressure boilers. Special attention has been given to water circulation, water-cooled fire chambers, draft control, and rolling of smooth boiler drums from hollow blocks.

Source: Consular Report 32545, GERMAN STEAM BOILER INDUSTRY DISPLAYS ACTIVITY, dated Jan. 21, 1935, from James H. Wright, American Vice-Consul, Cologne, Germany.

H. & V. Exposition in Chicago Next Year

The 4th International Heating & Ventilating Exposition will be held in Chicago at the new International Amphitheater, Jan. 27-31, 1936. Since 1930, the exposition has been held every two years, the first in Philadelphia, the second in Cleveland, and the third in New York. John Howatt is chairman of the exposition advisory committee, composed of F. H. Gaylor, A. B. Martin, J. M. Frank, E. M. Mittendorff, J. R. Vernon and R. E. Hattis. Conduct of the exposition and details of exhibit arrangement and leasing will be in charge of International Exposition Co., Grand Central Palace, New York, under personal direction of Charles F. Roth, manager.

Proposed Revision of Boiler Manufacturing Code

James D. Andrew, of New York, manager of the Boiler Manufacturing Industry Code Authority, formally submitted for NRA approval, at a public hearing, Feb. 26, a group of code amendments covering price filing changes and a liquidated damage plan for protection against code violations.

Centrifugal Pumping Trends in Waterworks Practice

Coincident with the growth of centrifugal pumping in the past 20 years an average increase in efficiency of about 15% has been realized, according to a paper before the New England Water Works Ass'n., March 21, by W. H. Sears, mechanical engineer of the Boston metropolitan district water supply commission. This improvement has been achieved mainly through higher speeds in the pump driving element and better hydraulic design.

Mr. Sears stated that the principal reason for abandonment of the reciprocating pump in favor of the centrifugal is first cost. Roughly, a vertical triple-expansion pumping engine, including installation, costs three times as much as a steam turbine reduction gear-driven centrifugal unit of the same capacity and 15 times as much as an electric motor-driven centrifugal. In all these cases the costs cover a complete pumping station, including foundations, buildings, boiler plant and accessories. This excess first cost is not offset by superior economy of the more expensive units.

Although record duties as high as 215,000,000 ft.lbs. per 1,000 lb. of steam have been attained with triple-expansion engines, steam-turbine centrifugal pumps have been so perfected in both turbine and pump ends that they are capable of coming within 8 to 10% of such duty when operated under the same steam conditions. An official test of a 60,000,000-g.p.d. turbine-driven pumping unit working under 300-ft. head at Milwaukee in 1932 gave a duty of over 195,000,000 ft.lb. per 1,000 lb. of steam, compared with 214,000,000 ft.lb. for the reciprocating pumping engines in the same station. This 60-m.g.d. unit occupied only the space required by a 20-m.g.d. engine-driven pumping unit. The steam turbine can utilize much higher steam pressures and temperatures than the steam engine, and had the Milwaukee turbine had the advantage of such steam conditions, it is probable, Mr. Sears declared, the duty of the turbine unit would have practically equalled that of the engine unit.

Earlier installations of centrifugal pumps for water works were with steam turbo drives. These were often installed in existing stations as replacements of obsolete machines or as enlargements of capacity, or both, where the boiler capacities available or in sight permitted this. Electric service was often of questionable dependability from the waterworks standpoint, which in many cases put it out of consideration, the speaker said. Today, with the improvement of electrical supply, with more effective rates, multiple sources of energy and in many cases increased political pressure the tide has swung strongly to electric motor units.

The centrifugal pump has been developed until its efficiency is about 90% or more. This is about the maximum hoped for. The economy of the steam turbine-driven centrifugal pump is about the same as that of the triple-expansion pumping engine. Electric motors applied to centrifugal pumps, and particularly the synchronous type almost universally used in units above 100 hp. have efficiencies as high as 96 to 98%. In the Brilliant pumping station at Pittsburg in 1932, 28-m.g.d. synchronous-motor-driven units at 365-ft. head attained an over-all efficiency from wire to water of 87.5%.

The speaker said that gasoline-driven pumping units for waterworks are chiefly valuable as reserve outfits. Diesel units are increasingly employed in sets rated under 400 hp. This is because of a growing realization of their economy and reliability, and of course purchased power may not be available or competitive with fuel-driven units.

COMING MEETINGS

American Society for Testing Materials—38th annual meeting, Book-Cadillac Hotel, Detroit, Mich., June 24-28 (exhibit at same time). R. E. Hess, assistant secretary, A.S.T.M., 260 S. Broad St., Philadelphia, Pa.

American Institute of Electrical Engineers—Summer convention, Ithaca, N. Y., June 24-28. H. H. Henline, national secretary, 33 West 39th St., New York, N. Y.

National Ass'n of Purchasing Agents—20th annual internat'l convention and Inform-a-Show, Waldorf-Astoria Hotel, New York, N. Y., May 20-23. Information from the Ass'n, 11 Park Place, New York, N. Y.

Oil & Gas Power Division, A.S.M.E.—8th nat'l meeting, Mayo Hotel, Tulsa, Okla., May 8-11. Also exhibit of oil engine parts, materials, accessories. Address Oil & Gas Power Division, A.S.M.E., 29 W. 39th St., New York, N. Y.

Great Lakes Power & Mech'l Exposition—June 24-28, on Steamer "Seeandbee," starting from Cleveland. Ernest H. Smith, managing director, 3910 Carnegie Ave., Cleveland, Ohio.

7th Midwest Power Show—Chicago, Ill., Oct. 14-18. G. E. Pfisterer, managing director, 1 North LaSalle St., Chicago, Ill.

American Society of Heating & Ventltg. Engrs.—Semi-annual meeting, Royal York Hotel, Toronto, Ont., June 17-19. A. V. Hutchinson, secretary, 51 Madison Ave., New York, N. Y.

PERSONALS

WALTER F. WELLS, first vice-president and general manager, and a director of Brooklyn Edison Co., retired March 1, after more than 42 years of service, over half of that period as vice-president and general manager. Just a few days before his retirement he was re-elected to these offices for 1935. No successor has as yet been picked. Mr. Wells has been a prominent figure in the electrical industry for many years. He was president of the Association of Edison Illuminating Co.'s in 1915-1916, and president of N.E.L.A. in 1918. Mr. Wells is 65 and has been with various Edison Co.'s since 1892. He superintended installation of Waterside Generating Station, New York.

KNUTT NORDENSEN, for many years chief designer of McIntosh & Seymour Corp., Auburn, N. Y., has been appointed chief engineer, a position made vacant by resignation of Paul A. Ritter, Sr., who has been chief engineer for ten years. Mr. Nordensen has been in charge of design for the company for 20 years, particularly guiding design of large engines, including both single- and double-acting up to and including 5,000 hp. in single units. Previous to 1915, Mr. Nordensen was designer for eight years at Aktiebolaget Atlas Diesel, Stockholm, Sweden. He has also been with several other diesel and oil engine companies.

Carl Volmar Anderson succeeds Mr. Nordensen as chief designer. For the past five years he has been responsible for the design of high-speed and railway type engines. James T. Lewis will be in charge of field service on diesels, and also chief inspector. William N. Nichols, in charge of field service work for the past eight years, will be in charge of experiments in combustion and all engine testing.

JACOB T. BARRON has been named vice-president in charge of electric operation, Public Service Electric & Gas Co., (N. J.) succeeding Edgar Allegaert, who died Feb. 26. Mr. Barron has been general manager of the electric department. Marion Penn, general superintendent of generation, succeeds Mr. Barron as general manager. Walker L. Cisler, planning and installation engineer, becomes general superintendent of generation in place of Mr. Penn. Mr. Barron came to Public Service in September, 1907, from General Electric, Mr. Penn from the same company in 1914.

G. W. BRUCKER has been appointed designing engineer of the Power Rectifier Engineering Department, Schenectady works, General Electric Co. He has been with the company since 1923.

SAM BARR has been appointed manager of sales in the New York office of Graver Tank & Mfg. Corp., East Chicago, Ind.

R. T. DINWIDDIE has resigned as manager, Refractories Division of M. W. Kellogg Co., New York, N. Y., to become vice-president of Refractory & Engineering Corp., 381 Fourth Ave., New York, N. Y. He will be in complete charge of sales of the company's cements and insulations.

B. D. CHRISTIAN has been elected vice-president of Crocker-Wheeler Electric Mfg. Co., Ampere, N. J. He has been with the company for 21 years, for the past nine as general sales manager, and previously representative in Cleveland and Chicago. Before joining Crocker-Wheeler, Mr. Christian was engineer of power, with Merchants Heating & Lighting Co., Indianapolis, Ind.

W. A. HAUCK has been appointed assistant to the president of Lukens Steel Co., Coatesville, Pa. He was formerly assistant comptroller of Bethlehem Steel Corp., and just prior to joining Lukens with American Iron & Steel Institute.

DR. DUGALD C. JACKSON, since 1907 head of the electrical engineering department at the Massachusetts Institute of Technology, noted consulting engineer and educator, will retire at the close of the present academic year. Prof. Jackson has had important connections with many large power developments, including the Conowingo hydro-electric project, the New England Power system's Fifteen Mile Falls undertaking, and others. From 1919 to 1930 he was senior partner of Jackson & Moreland, Boston, and during the world war he was a Lt. Col. of Engineers, A.E.F., where he was in charge of the procurement of power supply for about 70,000 hp. in generating facilities and related systems. He is a past-president of the A.I.E.E. and S.P.E.E.

ERLE G. HILL has joined Lukens Steel Co., Coatesville, Pa., as director of research. Since 1930 he has had a research fellowship at Mellon Institute of Industrial Research, Pittsburgh.

JOHN D. KING has been appointed district manager of the Montreal office, New Birks Bldg., 620 Cathcart St., of Detroit Stoker Co. of Canada, Ltd.

DR. FRANK B. JEWETT, president of Bell Telephone Laboratories, Inc., and vice-president of A.T.&T., has become national chairman of the campaign to raise the working capital fund of $161,000 for Engineering Index, Inc. This 50-year-old index and annotating service was discontinued by the A.S.M.E. a year ago.

J. K. KNIGHTON has been appointed manager of the air-conditioning sales department, Kelvinator Corp., Detroit, Mich.

PROF. HAROLD L. HAZEN, exchange professor from Ohio State University in the electrical engineering department of the Massachusetts Institute of Technology, has been awarded the Levy gold medal of the Franklin Institute for outstanding papers on the theory and design of servo-mechanisms. Presentation will be at Philadelphia May 15.

BYRON B. MORTON, formerly plant metallurgist at Baton Rouge Refinery, Standard Oil Co. of Louisiana, has joined the metallurgical staff of International Nickel Co., Inc., and will concentrate on problems involving use of nickel alloy materials in the petroleum industry.

R. M. ROOSEVELT, vice-president of Eagle-Picher Lead Co., Cincinnati, Ohio, in charge of New York office, has resigned to become president of American Zinc Institute. Willard E. Maston, vice-president, has been placed in charge of the New York sales division, and F. W. Potts, vice-president, has been appointed general manager. John R. MacGregor, vice-president, Eagle-Picher Sales Co., is to have charge of sales research and product development, and T. C. Carter has been appointed director of sales.

EVERETT E. STOCKWELL, for the past five years superintendent of Connecticut River Power Co.'s Vernon hydro-electric plant, will become superintendent of New England Power Co.'s Harriman Station on the lower Deerfield River in Vermont about May 1. William Hooper, who has been in charge for the past ten years at Harriman, will be transferred to Bellows Falls station of Bellows Falls Hydro-Electric Corp. as superintendent. Harry A. Ostrom, superintendent at Bellows Falls since its construction about 8 years ago, is to become superintendent at Vernon.

OBITUARIES

ASAHEL F. BENNETT, 81, former general manager of the Crane Co., Chicago, died in Northfield, Mass., March 21, following a shock a few days before. He was a native of Winchester, N. H., and after being associated with Crane in Chicago for many years, was in charge of the Crane factories at Bridgeport, Conn. He retired in 1925.

JOHN W. BRIDGE, 80, until seven years ago chief electrical engineer of Arlington Mills, Lawrence, Mass., died recently.

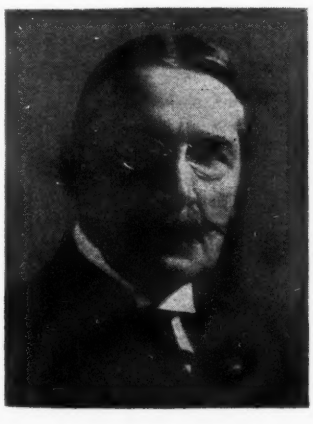
RALPH H. CLORE, general sales manager of Medart Co., Potomac and De Kalb Sts., St. Louis, Mo., died March 6. He had only recently been appointed general sales manager.

CAPT. WALTER MARTIN MCFARLAND, U.S.N. retired, 74, for 20 years manager of the Marine Department, Babcock & Wilcox Co., New York, who retired in 1931, died in Washington, March 4, after a brief illness. He went with B. & W. in 1910 as manager of the Marine Department, was very active in development of boilers, to operate at higher pressures and temperatures, and in addition built the greater part of the boilers installed in naval and merchant vessels during the World War. He was also for four years editor of the *Journal* of the Society of Naval Engineers.

DWIGHT PORTER, 79, since his retirement in 1921 professor-emeritus of hydraulic engineering at M.I.T., died at Malden, Mass., Feb. 26.

JOSEPH E. SWENDEMAN, 68, president and treasurer of J. E. Swendeman, Inc., Boston, Mass., died March 8 at Charlesgate Hospital, Cambridge, Mass., as the result of burns received in an accident three weeks before. He was the inventor of the Swendeman air separator and was active in power plant engineering for 35 years.

DR. MICHAEL I. PUPIN, 77, world-renowned physicist and inventor, died March 12 in New York, N. Y., from uremic poisoning. He had been ill for several months and in a coma for 48 hours. He retired from active work at Columbia University in 1931, where he was designated professor-emeritus of electro-mechanics. Inventor of the Pupin coil, which greatly extended the range of long-distance telephony, discoverer of many other practical, scientific formulas, Professor Pupin was once a shepherd boy in Serbia. He had been honored with medals and degrees, and regarded as one of the world's outstanding scientists.



GRANT W. SPEAR, 69, for the past 20 years vice-president of Dearborn Chemical Co. at New York, died in Palm Beach, Fla., Mar. 22. He had been in ill health and retired for the past five years. Mr. Spear was well known to older power engineers and in the engineering field generally.

ALBERT C. WEED, 68, vice-president of Borne-Scrymser Co., 17 Battery Place, New York, N. Y., died suddenly Feb. 23 at his home in Manhassett, L. I. He had been with the company continuously for 45 years, serving as secretary, treasurer and vice-president.

FRED CRAWFORD THOMPSON, 51, vice-president and general manager of Morse Chain Co., a subsidiary of Borg-Warner Corp., Ithaca, N. Y., and Detroit, died in Ithaca, March 6. He had been with the company since 1914, during the last five years in his present position.

BUSINESS NOTES

ILL. ELECTRIC VENTILATING CO., Chicago, Ill., has appointed the following representatives: N. J. Bigham, Y. M. C. A. Bldg., Des Moines, Ia.; George C. Mittauer, 4966 Hamilton Ave., Omaha, Neb.; and P. E. Ebersole, 214 S. Victor, Tulsa, Okla.; as representatives in their particular districts.

MACHINERY & WELDER CORP., 312 N. Sheldon St., Chicago, Ill., with branch offices in Milwaukee, has been appointed by Medart Co., St. Louis, to act as representative and distributor for power-transmission equipment in Northern Illinois, Northern Indiana and Southern Wisconsin.

GENERAL REFRACTORIES CO., 106 South Sixteenth St., Philadelphia, has appointed Patton Clay Mfg. Co., Syracuse, N. Y., and George F. Motter's Sons Supply Co., York, Pa., as dealer-agents in their particular areas.

COPPER & BRASS RESEARCH ASSN. has moved its office, as of April 1, from 25 Broadway to 420 Lexington Ave., New York, N. Y.

C. J. TAGLIABUE MFG. CO., Brooklyn, N. Y., has opened a new branch factory at 1916 Jackson St., Dallas, Tex., to replace the old Shreveport, La., office. Th new plant will be primarily for repair work, but will also carry stocks of standardized instruments. A. G. Koenig, southwestern district manager, will be in charge.

ATLAS SUPPLY CO., INC., 35-39 Woodward Ave., Brooklyn, N. Y., has been appointed warehouse distributors of Toncan iron sheets by Republic Steel Corp., Youngstown, Ohio.

PLIBRICO JOINTLESS FIREBRICK CO., 1800 Kingsbury St., Chicago, will install Beco-Turner baffle walls in the water-tube boilers formerly installed by Boiler Engineering Co., of Newark, N. J., which has discontinued business. Engineering and installation personnel of the latter company has been added to Plibrico's boiler-setting department. The company has issued a new 8-page bulletin on these baffles.

READING IRON CO., Reading, Pa., has formed a commercial research department to give technical service without charge to pipe buyers.

D. W. HAERING & CO., INC., Chicago, Ill., has moved its Detroit office to Fisher Building and appointed Franklin W. Murray district manager. Howard B. Graves, formerly of American District Telegraph Co., has been appointed district manager in charge of the Haering St. Louis office, and J. A. Lapierre, formerly of G. F. Sterne & Co., has been appointed in charge of the Toronto office.

ELGIN SOFTENER CORP., Elgin, Ill., has taken over the "Isometer" flowmeter developed by Isometer Corp., Milwaukee, which will now be operated as a division of Elgin, with offices at Elgin, Ill.

LINK-BELT CO., 910 S. Michigan Ave., Chicago, has appointed General Supply Co., S. A. Calle Balderas No. 56-58, Mexico, D. F., as stock-carrying distributor of conveying and power transmitting machinery in the federal district and State of Mexico.

EAGLE-PICHER SALES CO., Cincinnati, Ohio, has opened an insulation divisional headquarters in Temple Bar Bldg., Main and Court Sts., Cincinnati, to be headed by M. J. Washburn, divisional manager, with C. V. Blatz as contract department manager, G. P. Diers, staff engineer, and Albert Loring as consulting engineer.

NATIONAL COPPER PAINT CO. has been formed at 666 Lake Shore Drive, Chicago, with H. M. Rice, manager of Nichols Copper Co., Chicago (unit of Phelps-Dodge Corp.) as president, and C. L. Welch, executive vice-president. The company will produce liquid copper paint, liquid copper primer, and liquid copper reducer, under management of L. D. Pangborn, one of the discoverers of this new paint, who will be in charge of the 50,000-sq.ft. manufacturing plant.

CLYDE H. MILLER ASSOCIATES, 726 Jackson Place, N.W., Washington, D. C., have been appointed representatives in Washington, nearby Maryland and Virginia, for Birmingham Boiler Corp., Radiant Steel Products Co., and Rome Radiation Co.

NEVILLE & CLEARY, INC., Title Bldg., Atlanta, Ga., has been appointed exclusive sales representative for Tennessee, North Carolina, South Carolina, Alabama, Georgia and Florida for Ironton Firebrick Co., Ironton, Ohio.

LACLEDE-CHRISTY CLAY PRODUCTS CO., St. Louis, has moved its Chicago district sales office to 4452 West 5th Ave., Chicago. H. R. Hiller continues as district manager.

JUNIUS H. STONE has left Cork Insulation Co. to enter business at 270 Madison Ave., Suite 1606, New York, N. Y., under his own name, to continue cork and steel construction under his own patents.

NEW BULLETINS

Water Systems — Roots-Connersville Blower Corp., Connersville, Ind. 2-page Bulletin 260-B-13 on water systems for shallow wells and cisterns.

Power Transmission—Morse Chain Co., Ithaca, N. Y. Large-sized booklet, "Dependable Means of Power Transmission on Every Type of Machine," illustrates many typical applications of chain drive.

Vibrating Screen — Robins Conveying Belt Co., 15 Park Row, New York, N. Y. 4-page Vibrex Screen Bulletin No. 93 describes diagrams and gives applications of these units.

Leather Packing — Alexander Brothers, Inc., 406 N. Third St., Philadelphia, Pa. 24-page handbook No. A-49 is condensed leather packing catalog.

STRAWS

Pointing the way business winds blow

ELECTRO-MOTIVE CORP., subsidiary of General Motors, which is planning a diesel-electric locomotive plant at McCook, Ill., has purchased a 70-acre site. Austin Co., Cleveland, is now erecting the nine welded structural-steel buildings. The erecting and machine shop building, largest of the group, will be 550 ft. long by 170 ft. wide, with 104-ft. clear span, 49 ft. high, served by one 200-ton and two 30-ton electric traveling cranes. The plant will be the first complete factory for exclusive manufacture of diesel-electric locomotives in this country. These locomotives will be powered with Winton diesels.

WORTHINGTON PUMP & MACHINERY CORP. has purchased a 1,000-lb. Detroit rocking electric furnace for the Buffalo Works foundry. This will be used in making high-quality ferrous castings for diesel engines and compressors, utilizing shop borings and foundry scrap.

U. S. DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION, has awarded a contract of about $500,000 to Westinghouse Electric & Mfg. Co., for four 287.5-kilovolt oil circuit breakers and accessory equipment for Boulder Dam station. They will protect the station against faults that may occur on the Boulder Dam-Los Angeles transmission line. Having an operating time of three cycles, breakers will open high-voltage circuits within 0.05 sec. Each of the four breakers will be 27 ft. high and will weigh about 300,000 lb. They will be shipped next fall.

WEST VIRGINIA may have a bureau of boiler inspection, according to House Bill No. 337, introduced Feb. 14. The bill embodies provisions for a chief boiler inspector and assistant, lists their qualifications, provides for fees for inspection, licensing of persons, firms and corporations engaged in manufacturing of steam boilers, and provides for inspection reports and certificates to allow boiler operation. There is no boiler requirement law in force in that state now.

ROCKY MOUNTAIN POWER CO. has filed an application for extension of time on the Flathead project until May 23, 1938. Construction is to be resumed in May, 1936.

POTOMAC ELECTRIC LIGHT & POWER CO. received recently the heaviest single-car shipment ever made, a generator shaft, rotor and poles for a 25,000-kw. frequency converter set totalling 367,000 lb. The converter will deliver 25-cycle, single-phase power to the Pennsylvania Railroad.

STATE HOSPITAL FOR THE INSANE, Rankin, Co., Miss., has recently completed installation of powerhouse equipment, including Combustion Engineering Co. gas and oil burners and an extensive tunnel system. Work was done by S. S. Richard, of Jackson, Miss.

TVA has let contracts totaling $231,553 for power-plant equipment at Joe Wheeler Dam on the Tennessee River in Alabama. Bartlett-Hayward Co., Baltimore, received award of $202,700, Ingalls Iron Works Co., Birmingham, Ala., $21,489, and Virginia Bridge & Iron Co., Roanoke, Va., $7,364.

HARRISON, ARK., will hold a special city election April 9 to vote on a bond issue of $130,000 with which to construct a municipal power plant distribution system, according to Mayor Rex Worthington.

HETCH HETCHY DAM, which is 344.5 ft. from the lowest point of its foundation to its crest, will be raised to 429.5 ft., according to plans just approved by Secretary of the Interior Ickes. The additional 85 ft. will increase storage capacity 69%. The original PWA allotment of $3,500,000 has been reduced (at the request of the city and county of San Francisco) to a grant only of $1,058,000. The local government is planning to sell its bonds privately rather than to the government.

VIRGINIA EAST COAST UTILITIES, INC., is planning installation of a 480-hp. Fairbanks-Morse diesel engine at its Irvington, Va., plant, to replace an engine which failed several years ago. The new engine will be moved from West Point, Va., where it has been used only a short time. Transfer will be completed by the first of May. Meanwhile, a 240-hp. engine has been used at Irvington for emergency.

ELECTRIC POWER CO. of N. J. has asked a preliminary permit covering three power dams on the Delaware River to develop 237,000 hp.

BOARD OF TRUSTEES. STATE TRAINING SCHOOL, Plankinton, S. D., has plans under way for a new steam power house for central heating service. $30,000 has been authorized by the State Legislature. Charles Trimmer, Pierre, S. D., state engineer, in charge. A. R. Schlosser superintendent at the school.

THREE CALIFORNIA MUNICIPAL projects are maturing to be known as the Central San Joaquin Valley Municipal Utility District, with headquarters at Fowler; Central Counties Municipal Utility District, with headquarters at Tulare; and the Westover Public Utility District, Proberta. The first will be formed at a special election April 23, called by the Fresno County Board of Supervisors, Fresno; the new organization proposes to operate an electrical distribution system at Fowler and vicinity, acquiring present lines of San Joaquin Light & Power Corp. Power will be secured at wholesale from the San Joaquin company. Tulare County Board of Supervisors, Visalia, has called a special election May 10, to establish the Central Counties Municipal Utility District, to include oPrterville, Tulare, Visalia, Exeter, Hanford, Lindsay and several smaller communities; plans are being projected for a welded steel pipeline from the natural gas fields at Kettleman Hills, totaling about 90 mi. Project will cost close to $900,000, including distributing and control stations, service facilities, etc. Westover Public Utility District, likewise to be formed at a special election, will furnish electric service at Proberta and vicinity in Tehama County; transmission and distributing lines will be built.

KROGER GROCERY & BAKING CO., 35 East Seventh St., Cincinnati, Ohio, is completing plans and soon takes bids for construction of a new power plant for service at factory on State St. It is estimated to cost $150,000, with equipment. Tietig & Lee, 34 West Sixth St., architects; Fosdick & Hilmer, Union Trust Bldg., consulting engineers.

GREENWOOD COUNTY BOARD OF COMMISSIONERS, Greenwood, S. C., is beginning construction of proposed new hydro-electric generating plant in vicinity of Buzzard's Roost on Saluda River, for which financing has been arranged through Federal aid in amount of $2,627,000. Bids have been asked on prime movers, for which low price has been received from General Electric Co., Schenectady, N. Y., for generators at $325,000, and from Baldwin-Southwark Corp., Eddystone, Philadelphia, Pa., for water turbines at $144,000. Contracts will be awarded soon. Early call for bids will be made for power dam, power house spillway and other construction work. The Dam will be about 85 ft. high and 2,000 ft. long. Station will have an initial capacity of 22,500 hp. Project will include a transmission 100-mi. system for light and power service in a number of communities in Greenwood, Newberry and Laurens Counties. Daniel T. Duncan, engineer in charge.

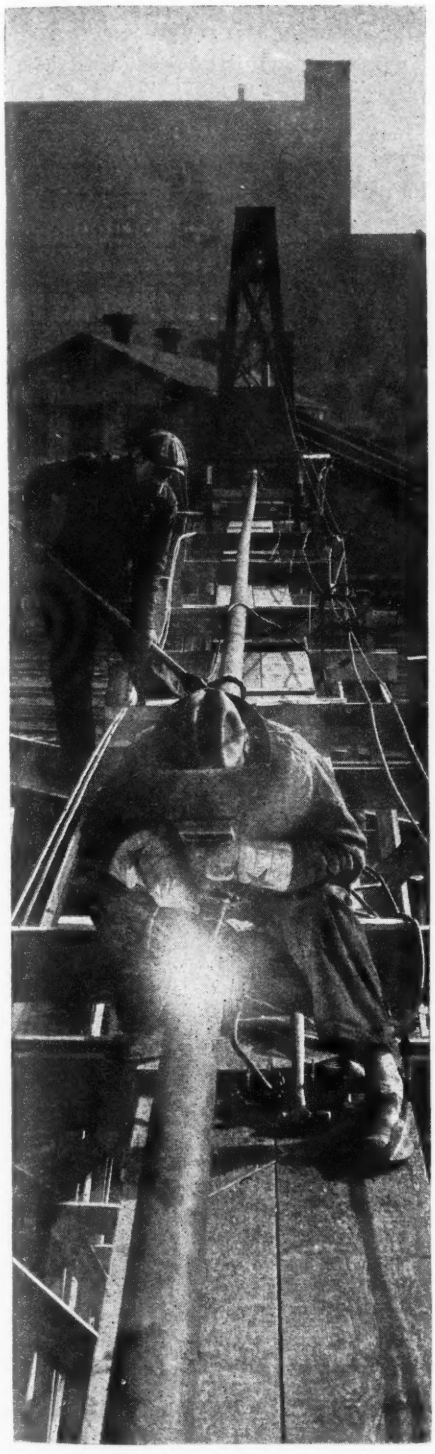
LA PLATA, MO., has secured permission from Federal Court to proceed with construction of proposed electric plant, and work will begin soon. Cost about $97,300. Financing arranged through PWA. E. T. Archer & Co., New England Bldg., Kansas City, Mo., consulting engineers.

EVERETT, WASH., plans a steel pipeline for pressure water supply for new local sulphite pulp mill to be constructed by the Weyerhaeuser Timber Co., Tacoma Bldg., Tacoma, Wash., consisting of 36- and 16-in. welded pipe, about 8,750 ft. long. It will cost $100,000. Financing is being arranged. Granville Paine is water superintendent. In connection with pulp mill, to occupy 200 x 800 ft., Weyerhaeuser will carry out expansion at steam-electric power plant used for present Mill A, with installation of additional equipment. Pulp mill will have a rating of 150 tons per day and will cost over $600,000. O. C. Schoenwerk company engineer.

PAN-AMERICAN AIRWAYS has purchased four Caterpillar diesel power units and two Caterpillar tractors for use on two tiny island bases far out in the Pacific Ocean, as a part of its development of a 6,000-mile trans-Pacific air route. One tractor and two power units go to one of the group of Midway Islands about 1,000 miles northwest of the Hawaiian Islands. The second tractor and remaining two units are for Wake Island, another thousand miles westward on the route. The diesel power units will drive d.c. generators to furnish field lights, radio beacons and communications; also pumping power. Due to the cost of obtaining fuel, it is planned to use lubricating oil drained from the planes as part of the fuel for the power units.

DENISON, IOWA, plans extensions and improvements in municipal electric plant, including installation of a new 2,500-sq.ft. boiler unit and auxiliary equipment. A fund of about $25,000 is being arranged for program, which will be carried out in the spring.

LIBERTY, TEX., has plans for a new municipal electric plant, including distrtibution lines and service facilities. Project to cost $125,000. Garrett Engrg. Co., 300 Hughes St., Houston, Tex., consulting engineer.



ONE PLANT REPLACES THREE

New 2,260-ft., 4- and 6-in. dia. steam line of Penna. R.R. at Cleveland carries steam to station and coach storage, closes two old plants. Though welded in mid-winter, none of over 60 joints failed at 300 lb. Here is shielded-arc welding of 110 ft. of pipe hanging between two 45-ft. towers over 7 tracks. Erected by Smith & Oby with Lincoln equipment.

SOUTHERN NEWSPAPER PUBLISHERS' ASS'N, E. K. Gaylord, president, Oklahoma City, Okla., will build a power plant for mill service, at new newsprint mill to be constructed on site now being secured in Georgia, to utilize Georgia slash pine as raw material. Entire project reported to cost over $500,000.

FORT COLLINS, COLO., is projecting plans for a municipal electric project to cost $660,000. It is proposed to acquire an existing station or build new plant, as may be determined, developing an initial capacity of about 4,000 kw.

CAMDEN, N. J., has secured tentative approval from PWA for proposed financing, pending for several months of $6,000,000 for construction of new municipal electric plant. Legislative action is being arranged to provide for the project, on which it is proposed to begin work at early date.

BUREAU OF POWER & LIGHT, LOS ANGELES, CALIF., plans large power substation on 11-acre tract of land on Whitnall Blvd., North Hollywood, now being acquired. Plant will be one of main distributing stations connected with 110,000-volt transmission line from Boulder Dam. The station will reduce voltage to 34,500 volts for primary service, and is estimated to cost $1,250,000. Work underway during summer, and bids for equipment scheduled soon.

CONTRACT for all pumping machinery for 18 cruisers now being built by the Navy Dept., Washington, D. C., at various navy yards, has been awarded to Buffalo Pumps, Inc., Buffalo, N. Y., the total award being $540,000. The pumping units will cover those for main feed, cruising feed and condensate service, motor-driven and turbine-propelled types.

PORT LAVACA, TEX., is having plans approved by PWA for proposed new municipal power plant, including cold storage and refrigerating, to be used in connection with waterfront development and improvements. Plant will occupy a site 120 x 185 ft., and is reported to cost over $125,000. Garrett Engrg. Co., Hughes Bldg., Houston, Tex., consulting engineer.

MEADVILLE, PA., is planning new municipal electric plant. Superintendent of Water & Light Dept. has been instructed by City Council to secure details and estimates of cost.

EAST PALESTINE, OHIO, has authorized early call for bids for extensions and improvements in municipal electric plant, including mechanical stoker, 5,000-sq.ft. boiler unit with superheater, soot blowers, feedwater regulator and accessory equipment, brick stack, new switchboard panels and other apparatus. A fund of $47,060 has been approved. Herbert Lemley, Director, Department of Safety-Service, in charge.

TEXAS GAS CONSERVATION CORP. is being organized as a state enterprise, under direction of R. B. Anderson, State House, Austin, Tex., State Tax Commissioner, to construct and operate a natural gas pipeline system from the Texas Panhandle gas fields to St. Louis, Mo., and Detroit, Mich. Plan to secure Federal aid of $60,000,000, to carry out the project, which will consist of a welded line of large capacity from near Amarillo, Tex. A series of compressor plants will be built along the route. Application for PWA fund in amount noted has been made.

SOUTHERN ICE & UTILITY CO., Little Rock, Ark., plans rebuilding of portion of local plant, recently destroyed by fire, with loss totaling over $125,000, including equipment. Company engineering department in charge.

BIG RAPIDS, MICH., is considering construction of new municipal hydro-electric generating plant, with electrical distribution system. Proposed to secure estimates of cost in near future.

DEPARTMENT OF WATER SUPPLY, GAS AND ELECTRICITY, Municipal Bldg., New York, N. Y., is arranging estimates of cost for two municipal electric light and power plants which the city proposes to construct through Federal aid. One will be at the Bronx Terminal Market, designed to serve a group of 31 public buildings in this area. It will be of diesel engine-generator type. The other will be near the foot of East Twenty-sixth St., at the East River. P. Davidson is commissioner.

TEXAS WOOLEN MILLS CORP., Dallas, Tex., care of M. C. Cotton, 202 Burt Bldg., Dallas, recently organized by Mr. Cotton and associates, plans power plant at proposed textile mill on land being acquired at San Angelo, Tex. Project will cost about $450,000.

MEDFORD, WIS., is having surveys and estimates made by the Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer, for new municipal electric plant, with distribution lines. Early date.

MARYSVILLE COLD STORAGE CO., Marysville, Wash., is considering construction of new cold storage and refrigerating plant. Cost over $50,000, with equipment. Cecil Clayton president.

PRESTON, MINN., has plans maturing for extensions and improvements in municipal electric plant, with installatiton of new diesel equipment, fuel-oil storage tank, pumping machinery and accessories, switchboard and miscellaneous equipment. Cost about $40,000. Financing being arranged through Federal aid. G. M. Orr, Baker Bldg., Minneapolis, Minn., consulting engineer.

WILLIAMS, ARIZ., is planning new municipal electric plant, for which list of equipment will be determined at early date. Cost estimated at $50,000. Financing will be through Federal aid.

OSCEOLA, ARK., plans installation of additional equipment in municipal electric plant, including engine unit and accessories. To ask bids soon.

FREDERICK, OKLA., is arranging for a special election early in April, to vote bonds for $125,000, for a new municipal electric plant, using diesel-generator units. An electrical distribution system will also be built. Early call for bids. Another Oklahoma municipality, Hominy, has preliminary plans for a similar project, including distributing lines, reported to cost close to $100,000. Financing through Federal aid. V. V. Long & Co., Colcord Bldg., Oklahoma City, Okla., consulting engineers for both projects.

TIME TO THINK . . .

Hello! Its good to be back. Phil Swain, editor of *Power,* has invited me to take up a page of his space every month again to air some of my notions. He wrote, "This vacation from writing probably has given you time to think up a lot of new ideas."

As a matter of fact, it didn't. I used to say, just like everybody else, "If I only had time to think!" Well, I've had it, and let me tell you, I didn't get much thinking done. It always seemed like, if I only had time, I could get most of my muddled ideas straightened out. But when I did have time, the old top-knot wouldn't operate like it did when I was busy.

I did have one idea though, and it came while I was looking over *Power* not long ago. I'm one of these cover-to-cover readers, which means both ads and text. All at once I noticed that every ad treated me—and I suppose 23,000 other readers—as a *buyer,* or at least a *prospect* anyhow.

I'm wondering why some advertiser won't give me the dope he gives his own salesmen, dollars and cents instead of B.t.u.'s and performance all the time. I get the performance story easy, but the money stuff is harder. And that's what I have to have. After all, I'm *buying* equipment every day, and I have to sell the idea to the Big Boss on the basis of how many dollars he'll save.

Let's take pumps for an example. Instead of blowing about how good his pump is, why doesn't some manufacturer say: "How about your water system? Too many turns in the line, too much suction head, pumps more than ten years old—all may be costing you important money. How much more does it cost you per million gallons of water than it should? We'd be glad to help you figure it out if you'll let us send over one of our men. You know your plant better than anyone else, but our man knows his pumps."

That to me, and to you too, I'll bet, would be horse sense. But what do they say? Just "Let us send our expert to help your management solve its power problems." If they could send out a man like that, he ought to have my job. But he couldn't begin to know as much about my plant in a few hours as I've learned in fifteen years. And why help the management—why not help me? After all, *I'm* the boy that buys equipment—the Boss only okays the spending.

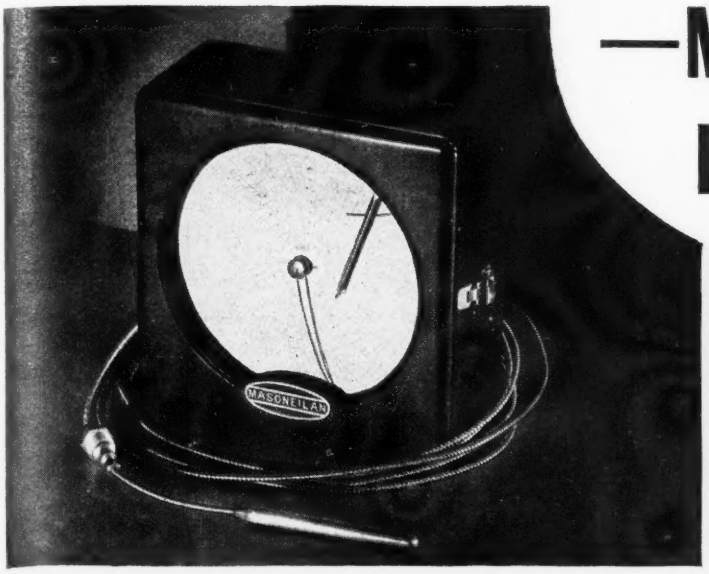
If an equipment man helps *me* show my Boss where I can save money, it stands to reason I won't forget his equipment when I buy, because he has put me wise to some things that will help me with my Boss. He's got me rooting for *his particular equipment.*

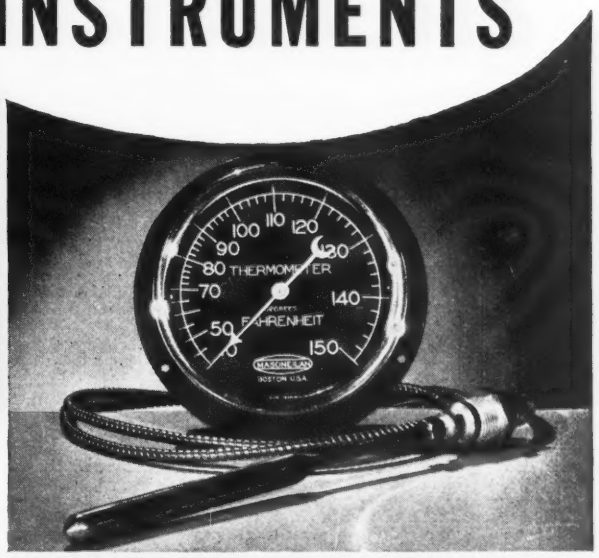
But I suppose advertisers are just like me—they want time to think, but they don't do it until they haven't got time.

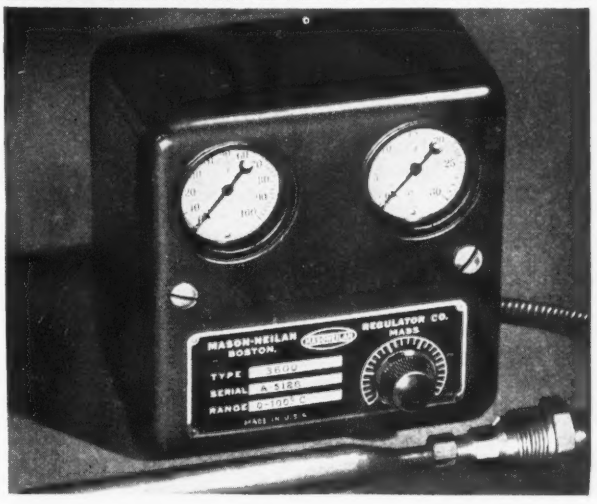
George Edwards

GEORGE EDWARDS
Engineer

For Indicating . . Recording . . Controlling Temperature —MASON-NEILAN INSTRUMENTS







Whether you brew beer . . . generate power . . . refine oil . . . bake pottery or perform any of a thousand other industrial operations — you must control temperatures with a firm hand or your product quality and profits may hit the skids. To make this control easy and convenient, Mason-Neilan has developed a full line of instruments for indicating . . . recording . . . and controlling industrial process temperatures.

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- (Top Right) **Mason-Neilan Indicating Thermometer.** Extremely simple and rugged in construction. Provides a reliable, inexpensive indication of process temperatures. For applications where chart records of temperatures are not required.
- (Lower Right) **Mason-Neilan Indicating Temperature Controller.** A newly developed, low priced air-operated instrument that is providing Industry with precise temperature control. These controllers are fully indicating and quickly adjusted. An exclusive sensitivity selector permits them to be readily synchronized with the speed of your process.

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NEW BULLETINS

Variable-Speed Control — Reeves Pulley Co., Columbus, Ohio. 6-page folder, "Inside Facts About Variable Speed Control," describing interiors of Reeves sped units.

Spray Cooling—Binks Mfg. Co., 3106 Carroll Ave., Chicago, Ill. 8-page bulletin on indoor forced-draft spray-cooling towers, Gives data on construction, shows installations, typical arrangements, size and capacity data, and specifications. Also another 8-page bulletin devoted to atmospheric spray-cooling towers for air-conditioning and refrigeration, with engineering information and other helpful data.

Packing and Accessories—Greene, Tweed & Co., 109 Duane St., New York, N. Y. Catalog No. 16 of Mill Supplies and Contractors' Specialties, lists data on packing, belts and fasteners, gasket tubing, soft hammers, leather, lubricans, wrenches, etc.

Valve Chart—Merco Nordstrom Valve Co., Pittsburg, Pa. Service chart describing, under headings "Operation," "Adjustment," "Lubrication" and "Repair," proper care for Nordstrom lubricated plug valves. Printed on heavy stock suitable for tacking on wall.

Gas Engines—Meriam Co., 1955 West 112th St., Cleveland, Ohio. Series of informative monthly post cards on gas engines, first giving useful data on valve settings, second on lubrication problems, etc.

Valves — Homestead Valve Mfg. Co., Coraopolis, Pa. 46-page illustrated reference book No. 37 describes complete line of valves including protected-seat hydraulic operating valves and protected-seat spray valves, as well as vapor spray cleaning machines.

Gas Regulators — Chapling-Fulton Mfg. Co., 2840 Penn Ave., Pittsburgh, Pa. 1935 illustrated catalog, 76 pages on Fulton gas regulator with automatic cutoff for natural gas, and Fulton duplex sensitive gas governor. Detailed data.

Motors—Louis Allis Co., Milwaukee, Wis. Three new bulletins: Bulletin No. 507 on d.c. motors, Bulletin 510 on totally-inclosed, fan-cooled motors, and Bulletin 514 on single-phase capacitor motors.

Steel Forgings—Kropp Forge Co., 5301 W. Roosevelt Road, Chicago, Ill. 4-page bulletin, "Heat-Treated Forgings."

Maintenance—L. J. Wing Mfg. Co., 154 W. 14th St., New York, N. Y. Technical article "The Possibility of Reducing Maintenance Costs Through Fuel Used," by A. E. Seeling, Pres. Reproduced as 8-page bulletin.

Stainless Steel — Republic Steel Corp., Youngstown, Ohio. 16-page illustrated Booklet 125-A is new edition containing latest data on various Enduro 18-8 stainless steels. Includes table showing degree of corrosion resistance of three types in presence of several hundred individual chemicals and reagents.

Feedwater Regulators—Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio. 16-page "Bailey Feedwater Regulators," No. 83, deals with thermal hydraulic regulators with diagrams and describes regulating valves of both tight-seating and sleeve-type construction; also data on excess pressure valves and tabulation of valve dimensions and list of users.

Chains and Sprockets—C. O. Bartlett & Snow Co., Cleveland, Ohio. Bulletin No. 74, "Chain, Sprockets, Buckets," gives data on standard detachable, pintle, ley bushed, combination, drag, roller, transfer, steel bushed and drop forged chain and chain attachments, and gives dimensions, weights, working loads, etc. 18 pages on prices and weights of sprocket wheels.

Bakelite — Bakelite Corp., River Road, Bound Brook, N. J. 39-page booklet, "Bakelite Varnish, Enamel, Lacquer and Cement Heat Hardenable," describes characteristic uses and technique involved in handling these materials. Used for central station armature impregnation, coating of paper wound tubes for textile yarns, etc.

Rebuilt Gas Engines—Meriam Co., 1955 W. 112th St., Cleveland, Ohio. Operating instructions on oil and lubrication data for uses of this company's rebuilt gas engines, as well as others. Prepared jointly by this company and engineers of Socony-Vacuum Oil Co.

Boulder Dam—Ingersoll-Rand Co., Phillipsburg, N. J. 48-page booklet, "The Story of Boulder Dam," includes reprints with detail description of cofferdams, cableways, tunnels, penstocks and canyon wall outlets. Beautifully illustrated.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ark., Harrison—City election Apr. 9 to vote $130,000 bonds to install light plant. Albert C. Moore, P. O. Box 305, Joplin, Mo., engr.

Calif., Los Angeles—Bureau Power & Light, 207 South Bway., plans electrical distributing station to handle electrical current from Boulder Dam, to be equipped to transform 110,000 volt current to 34,500 for distribution to substations, Whitnuall Blvd., North Hollywood, $1,250,000. **Maturity this summer.** H. C. Gardett, c/o owner, chief design eng.

Calif., Napa—Preliminary estimates of cost submitted to City Council for municipal electric power plant and distribution system, $340,000. Cost of 4 unit 1,600 kw. Diesel generating plant $181,948, and 5 unit, 2,000 kw, $223,888. Acquisition or construction of distribution system would involve an additional expenditure. Report being studied by Advisory Bd. City Council.

Calif., Susanville—City to have surveys made for water system and municipal power plant. To exceed $50,000. H. S. Riddell, city engr.

Ill., Centralia—City, c/o City Clerk, making plans power plant, incl. generating equipment, switchboard, auxiliaries, and accessories, $477,000. P.W.A. project. Bond issue voted. Baumes & McDevitt, 1871 Railway Exch. Bldg., St. Louis, Mo., engrs.

Ia., Fairfield—Municipality voted $100,000 constructing electric light and power plant and distribution lines.

Ia., Manning—Municipality making surveys electric light and power plant. To exceed $40,000. **Maturity indefinite.**

Md., Cambridge — Mayor and City Council plan electric power plant. $400,000. Engineer not appointed.

Mass., Chelsea—Commonwealth of Massachusetts, Trustees of Soldiers Home, W. J. Keville, pres., State House, Boston, plans power house. To exceed $100,000. Engineer not appointed. Will make application to P.W.A. for funds.

Mass., Lowell—City, J. J. Bruin, mayor, City Hall, plans municipal electric light plant. Engineer not appointed.

Mass., Marion—Town, Bd. Selectmen, Town Hall, appointed committee consisting of B. E. Waters, G. B. Crapo, and R. E. Washburn, to select site, engineer, determine costs, etc., for municipal light plant.

Mich., Big Rapids—Municipality, plans hydro-electric power plant. To exceed $28,500.

Mich., Flint—City will put proposition before electors on Apr. 1 for bond election to erect 2 story, brick, steel, concrete municipal electric power plant with P.W.A. financing, incl. modern steam driven, electric generating equipment, $6,000,000. E. L. Halloway, dir. P. Utilities, Flint.

Mich., Sparta—Consumers Power Co., Jackson, plans power sub-station, transformers, etc., $40,000.

Mich., Stambaugh—Municipality plans electric light and power plant. To exceed $30,000. Architect not appointed. **Maturity indefinite.**

N. J., Camden—City municipal light and power plant and distribution system recommended for P.W.A. approval. $6,000,000. Scofield Eng. Co., Commercial Trust Bldg., Phila., Pa., engrs.

N. J., Cedar Grove—Essex Co. plans modernizing and enlarging power plant at Hospital. $125,000. P.W.A. project. R. Carey, 333 Fulton St., Newark, engr.

N. Y., Albany—Municipality election in November to vote on construction electric light plant and distribution system. To exceed $500,000.

N. Y., Canandaigua — City plans municipal light and power plant. $340,000. L. C. Reynolds, engr., 387 Sastle St., Geneva, completed survey but action postponed indefinitely.

N. Y., Elmira—Bd. Supervs. Chemung Co., preliminary surveys in progress for electric power plant. To exceed $100,000. **Maturity indefinite.**

N. Y., Monticello—Municipality preliminary surveys electric power plant. To exceed $50,000. **Maturity indefinite.** L. T. Klauder, Lincoln-Liberty Bldg., Phila., Pa., archt.

N. Y., Ocean Beach—Municipality bids after Apr. 20, constructing diesel-engined power plant, $75,000. P.W.A. project. H. P. Daniels, 70 East 45th St., New York, engrs.

N. Y., Port Jervis—Municipality preliminary surveys, electric power and light plant. To exceed $50,000. **Maturity indefinite.** L. T. Klauder, Lincoln-Liberty, Bldg., Phila., Pa., archt.

N. Y., Rockville Center—Village Bd., has decided to withdraw application for P.W.A. loan and grant of $260,000 for installing additional lighting plant unit and instead will apply for $78,000 outright grant. Balance of necessary money will be raised through sale of bonds by village.

N. D., Watford City—Municipality plans electric light and power plant. To exceed $30,000. Engineer not appointed. **Maturity indefinite.**

O., Berea—City plans application to P.W.A. for grant to finance construction municipal light plant. $130,000. W. Root, Bagley Rd., city engr.

O., Cleveland—City, W. J. Rogers, dir. P. Utilities, plans power plant extension, increasing capacity of Collinwood sub-station, $53,000; and cables and switches, $47,000.

O., Sylvania—City, H. C. Quinnell, mayor considering construction of electric light plant $150,000. G. Champe, municipal engr.

Okla., Shawnee—City plans installation 300 hp. diesel engine pumping unit, $60,000. W. R. Holway, Tulsa, engr.

Pa., Ashley—Municipality, c/o G. W. Evans, Ashley, plans electric power plant. To exceed $30,000. **Maturity indefinite.**

Pa., Meadville—City, G. S. Maxwell, clk., plans municipal light and power plant. To exceed $105,000. R. L. Phillips, city engr. **Maturity indefinite.**

Tenn., Chattanooga—City voted $8,000,000 bonds, municipal power plant for distribution of Tennessee Valley Authority electricity.

Tex., Brownwood — R. O. Mathews, Brownwood, soon takes competitive bids for construction of power plant for manufacturing and furnishing power to city for lighting and power machinery operation. $200,000. W. L. Dickson, Brownwood and Dallas, engr.

Tex., San Angelo—City election in April to vote $900,000 bonds for power plant. P.W.A. funds allotted. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Tex., San Antonio—San Antonio Central Power Co., c/o R. W. Morrison, pres., St. Anthony Hotel, St. Marys and Travis Sts., plans power plant on grounds adjoining St. Anthony Hotel building, Travis and Navarro Sts., to supply power for newly conditioned hotel. Part of work already started. Some machinery yet remains to be purchased. Diesel engines and dynamos. $100,000. Private plans.

Tex., Stephenville—City voted bonds for municipal electric light and power plant. $190,000.

Vt, St. Johnsbury—Town, Bd. Selectment, R. W. Orebaugh, town mgr., Town Hall, plans municipal light and power plant. $600,000.

Utah, Bountiful—Municipality bids late in spring, constructing electric light, power plant and distribution system. $100,000.

Vt., Hartford—Town, A. E. Watson chn. Committee in charge. Town Hall, plans electric light plant, also waterworks system. Engineer not appointed.

Vt., Putney — Town, Bd. Selectmen, Town Hall, plans electric light plant. Engineer not appointed. **Maturity indefinite.**

Wis., Hudson—Willow River Power Co., plans rebuilding hydro-electric plant damaged by flood. To exceed $28,000.

Wis., Medford — City reports in progress, municipal power plant. Burns & McDonnell Eng. Co., 107 Linwood Blvd., Kansas City, Mo., engrs.

Wis., Shawano—Municipal Water & Electric Dpt., B. Page, secy., plans by Auler, Jenson & Brown, Oshkosh. 2 story, 52x110 ft., brick, steel power house addition, fire station and city garage.

Que., Montreal—Quebec Streams Conn., Notre Dame St. E., preparing plans power development on Rimouski and Harricane Rivers, Abitibi Dist. O. Lefevre, ch. engr.

Argentina, Buenos Aires — Government preparing plans 14,000 hp. hydro power station on Tercero River, Cordolic.

Egypt, Cairo—Egyptian State Railways, bids in April, electrification of Helouan Section. $5,000,000.